MiCOM P115

Dual / CT-Powered Overcurrent Relay

P115/EN M/B41

Software Version 1D
Hardware Suffix A

Technical Manual

Schneider Electric

Note: The technical manual for this device gives instructions for its installation, commissioning, and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate Schneider Electric technical sales office and request the necessary information.

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SAFETY SECTION

STANDARD SAFETY STATEMENTS AND EXTERNAL LABEL INFORMATION FOR SCHNEIDER ELECTRIC EQUIPMENT

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1. INTRODUCTION

This guide and the relevant equipment documentation provide full information on safe handling, commissioning and testing of this equipment. This Safety Guide also includes descriptions of equipment label markings.

Documentation for equipment ordered from Schneider Electric is despatched separately from manufactured goods and may not be received at the same time. Therefore this guide is provided to ensure that printed information which may be present on the equipment is fully understood by the recipient.

The technical data in this safety guide is typical only, see the technical data section of the relevant product publication(s) for data specific to a particular equipment.

Before carrying out any work on the equipment the user should be familiar with the contents of this Safety Guide and the ratings on the equipment's rating label.

Reference should be made to the external connection diagram before the equipment is installed, commissioned or serviced.

Language specific, self-adhesive User Interface labels are provided in a bag for some equipment.

2. HEALTH AND SAFETY

The information in the Safety Section of the equipment documentation is intended to ensure that equipment is properly installed and handled in order to maintain it in a safe condition.

It is assumed that everyone who will be associated with the equipment will be familiar with the contents of that Safety Section, or this Safety Guide.

When electrical equipment is in operation, dangerous voltages will be present in certain parts of the equipment. Failure to observe warning notices, incorrect use, or improper use may endanger personnel and equipment and also cause personal injury or physical damage.

Before working in the terminal strip area, the equipment must be isolated.

Proper and safe operation of the equipment depends on appropriate shipping and handling, proper storage, installation and commissioning, and on careful operation, maintenance and servicing. For this reason only qualified personnel may work on or operate the equipment.

Qualified personnel are individuals who:

- Are familiar with the installation, commissioning, and operation of the equipment and of the system to which it is being connected;
- Are able to safely perform switching operations in accordance with accepted safety engineering practices and are authorised to energize and de-energize equipment and to isolate, ground, and label it;
- Are trained in the care and use of safety apparatus in accordance with safety engineering practices;
- Are trained in emergency procedures (first aid).

The equipment documentation gives instructions for its installation, commissioning, and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate Schneider Electric technical sales office and request the necessary information.

3. SYMBOLS AND EXTERNAL LABELS ON THE EQUIPMENT

For safety reasons the following symbols and external labels, which may be used on the equipment or referred to in the equipment documentation, should be understood before the equipment is installed or commissioned.

3.1 Symbols

Caution: refer to equipment documentation	Caution: risk of electric shock
Protective Conductor (*Earth) terminal	Functional/Protective Conductor (*Earth) terminal. Note: This symbol may also be used for a Protective Conductor (Earth) Terminal if that terminal is part of a terminal block or sub-assembly e.g. power supply.

*NOTE: THE TERM EARTH USED THROUGHOUT THIS GUIDE IS THE DIRECT EQUIVALENT OF THE NORTH AMERICAN TERM GROUND.

3.2 Labels

See Safety Guide (SFTY/4L M/G11) for equipment labelling information.

4. INSTALLING, COMMISSIONING AND SERVICING

Equipment connections

Personnel undertaking installation, commissioning or servicing work for this equipment should be aware of the correct working procedures to ensure safety.

The equipment documentation should be consulted before installing, commissioning, or servicing the equipment.

Terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated.

The clamping screws of all terminal block connectors, for field wiring, using M4 screws shall be tightened to a nominal torque of 1.3 Nm.

Equipment intended for rack or panel mounting is for use on a flat surface of a Type 1 enclosure, as defined by Underwriters Laboratories (UL).

Any disassembly of the equipment may expose parts at hazardous voltage, also electronic parts may be damaged if suitable electrostatic voltage discharge (ESD) precautions are not taken.

If there is unlocked access to the rear of the equipment, care should be taken by all personnel to avoid electric shock or energy hazards.

Voltage and current connections shall be made using insulated crimp terminations to ensure that terminal block insulation requirements are maintained for safety.

Watchdog (self-monitoring) contacts are provided in numerical relays to indicate the health of the device. Schneider Electric strongly recommends that these contacts are hardwired into the substation's automation system, for alarm purposes.

To ensure that wires are correctly terminated the correct crimp terminal and tool for the wire size should be used.

The equipment must be connected in accordance with the appropriate connection diagram.

Protection Class I Equipment

- Before energizing the equipment it must be earthed using the protective conductor terminal, if provided, or the appropriate termination of the supply plug in the case of plug connected equipment.
- The protective conductor (earth) connection must not be removed since the protection against electric shock provided by the equipment would be lost.
- When the protective (earth) conductor terminal (PCT) is also used to terminate cable screens, etc., it is essential that the integrity of the protective (earth) conductor is checked after the addition or removal of such functional earth connections. For M4 stud PCTs the integrity of the protective (earth) connections should be ensured by use of a locknut or similar.

The recommended minimum protective conductor (earth) wire size is 2.5 mm^2 (3.3 mm^2 for North America) unless otherwise stated in the technical data section of the equipment documentation, or otherwise required by local or country wiring regulations.

The protective conductor (earth) connection must be low-inductance and as short as possible.

All connections to the equipment must have a defined potential. Connections that are pre-wired, but not used, should preferably be grounded when binary inputs and output relays are isolated. When binary inputs and output relays are connected to common potential, the pre-wired but unused connections should be connected to the common potential of the grouped connections.

Before energizing the equipment, the following should be checked:

- Voltage rating/polarity (rating label/equipment documentation),
- CT circuit rating (rating label) and integrity of connections,
- Protective fuse rating,
- Integrity of the protective conductor (earth) connection (where applicable),
- Voltage and current rating of external wiring, applicable to the application.

Accidental touching of exposed terminals

If working in an area of restricted space, such as a cubicle, where there is a risk of electric shock due to accidental touching of terminals which do not comply with IP20 rating, then a suitable protective barrier should be provided.

Equipment use

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Removal of the equipment front panel/cover

Removal of the equipment front panel/cover may expose hazardous live parts, which must not be touched until the electrical power is removed.

UL and CSA/CUL Listed or Recognized equipment

To maintain UL and CSA/CUL Listing/Recognized status for North America the equipment should be installed using UL or CSA Listed or Recognized parts for the following items: connection cables, protective fuses/fuseholders or circuit breakers, insulation crimp terminals and replacement internal battery, as specified in the equipment documentation.

For external protective fuses a UL or CSA Listed fuse shall be used. The Listed type shall be a Class J time delay fuse, with a maximum current rating of 15 A and a minimum d.c. rating of 250 Vd.c., for example type AJT15.

Where UL or CSA Listing of the equipment is not required, a high rupture capacity (HRC) fuse type with a maximum current rating of 16 Amps and a minimum d.c. rating of 250 Vd.c. may be used, for example Red Spot type NIT or TIA.

Equipment operating conditions

The equipment should be operated within the specified electrical and environmental limits.

Current transformer circuits

Do not open the secondary circuit of a live CT since the high voltage produced may be lethal to personnel and could damage insulation. Generally, for safety, the secondary of the line CT must be shorted before opening any connections to it.

For most equipment with ring-terminal connections, the threaded terminal block for current transformer termination has automatic CT shorting on removal of the module. Therefore external shorting of the CTs may not be required, the equipment documentation should be checked to see if this applies.

For equipment with pin-terminal connections, the threaded terminal block for current transformer termination does NOT have automatic CT shorting on removal of the module.

External resistors, including voltage dependent resistors (VDRs)

Where external resistors, including voltage dependent resistors (VDRs), are fitted to the equipment, these may present a risk of electric shock or burns, if touched.

Battery replacement

Where internal batteries are fitted they should be replaced with the recommended type and be installed with the correct polarity to avoid possible damage to the equipment, buildings and persons.

Insulation and dielectric strength testing

Insulation testing may leave capacitors charged up to a hazardous voltage. At the end of each part of the test, the voltage should be gradually reduced to zero, to discharge capacitors, before the test leads are disconnected.

Insertion of modules and pcb cards

Modules and PCB cards must not be inserted into or withdrawn from the equipment whilst it is energized, since this may result in damage.

Insertion and withdrawal of extender cards

Extender cards are available for some equipment. If an extender card is used, this should not be inserted or withdrawn from the equipment whilst it is energized. This is to avoid possible shock or damage hazards. Hazardous live voltages may be accessible on the extender card.

External test blocks and test plugs

Great care should be taken when using external test blocks and test plugs such as the MMLG, MMLB and MiCOM P990 types, hazardous voltages may be accessible when using these. *CT shorting links must be in place before the insertion or removal of MMLB test plugs, to avoid potentially lethal voltages.

*Note: When a MiCOM P992 Test Plug is inserted into the MiCOM P991 Test Block, the secondaries of the line CTs are automatically shorted, making them safe.

Fiber optic communication

Where fiber optic communication devices are fitted, these should not be viewed directly. Optical power meters should be used to determine the operation or signal level of the device.

Cleaning

The equipment may be cleaned using a lint free cloth dampened with clean water, when no connections are energized. Contact fingers of test plugs are normally protected by petroleum jelly, which should not be removed.

5. DECOMMISSIONING AND DISPOSAL

De-commissioning

The supply input (auxiliary) for the equipment may include capacitors across the supply or to earth. To avoid electric shock or energy hazards, after completely isolating the supplies to the equipment (both poles of any dc supply), the capacitors should be safely discharged via the external terminals prior to de-commissioning.

Disposal

It is recommended that incineration and disposal to water courses is avoided. The equipment should be disposed of in a safe manner. Any equipment containing batteries should have them removed before disposal, taking precautions to avoid short circuits. Particular regulations within the country of operation, may apply to the disposal of the equipment.

6. TECHNICAL SPECIFICATIONS FOR SAFETY

Unless otherwise stated in the equipment technical manual, the following data is applicable.

6.1 Protective fuse rating

The recommended maximum rating of the external protective fuse for equipments is 16A, high rupture capacity (HRC) Red Spot type NIT, or TIA, or equivalent. Unless otherwise stated in equipment technical manual, the following data is applicable. The protective fuse should be located as close to the unit as possible.

CAUTION - CTs must NOT be fused since open circuiting them may produce lethal hazardous voltages.

6.2 Protective Class

IEC 60255-27: 2005 EN 60255-27: 2006	Class I (unless otherwise specified in the equipment documentation). This equipment requires a protective conductor (earth) connection to ensure user safety.

6.3 Installation Category

IEC 60255-27: 2005 EN 60255-27: 2006	Installation Category III (Overvoltage Category III): Distribution level, fixed installation. Equipment in this category is qualification tested at 5 kV peak, 1.2/50 µs, 500 Ω, 0.5 J, between all supply circuits and earth and also between independent circuits.

6.4 Environment

The equipment is intended for indoor installation and use only. If it is required for use in an outdoor environment then it must be mounted in a specific cabinet or housing which will enable it to meet the requirements of IEC 60529 with the classification of degree of protection IP54 (dust and splashing water protected).

Pollution Degree - Pollution Degree 2 Altitude - Operation up to 2000m IEC 60255-27:2005 EN 60255-27: 2006	Compliance is demonstrated by reference to safety standards.

IT

INTRODUCTION

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

IT

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FIGURES

Figure 1: Functional diagram of P115 with all ordering options included 7

IT

1. MiCOM DOCUMENTATION STRUCTURE

The manual provides a functional and technical description of the MiCOM protection relay and a comprehensive set of instructions for the relay's use and application.

The section contents are summarized below:

P115/EN IT Introduction

A guide to the MiCOM range of relays and the documentation structure. Also a general functional overview of the relay and brief application summary are given.

P115/EN TD Technical Data

Technical data including setting ranges, accuracy limits, recommended operating conditions, ratings and performance data. Compliance with norms and international standards is quoted where appropriate.

P115/EN GS Getting Started

A guide to the different user interfaces of the protection relay describing how to start using it. This section provides detailed information regarding the communication interfaces of the relay, including a detailed description of how to access the settings database stored within the relay.

P115/EN ST Settings

List of all relay settings, including ranges, step sizes and defaults, together with a brief explanation of each setting.

P115/EN OP Operation

A comprehensive and detailed functional description of all protection and non-protection functions.

P115/EN AP Application Notes

This section includes a description of common power system applications of the relay, calculation of suitable settings, some typical worked examples, and how to apply the settings to the relay.

P115/EN MR Measurements and Recording

Detailed description of the relays recording and measurements functions.

P115/EN CM Commissioning

Instructions on how to commission the relay, comprising checks on the calibration and functionality of the relay.

P115/EN MT Maintenance

A general maintenance policy for the relay is outlined.

P115/EN TS Troubleshooting

Advice on how to recognize failure modes and the recommended course of action. Includes guidance on who at Schneider Electric to contact for advice.

P115/EN SG Symbols and Glossary

List of common technical abbreviations found within the product documentation.

P115/EN IN Installation

Recommendations on unpacking, handling, inspection and storage of the relay. A guide to the mechanical and electrical installation of the relay is provided, incorporating earthing recommendations. All external wiring connections to the relay are indicated.

P115/EN CM Communication Database

This section provides an overview regarding the SCADA communication interfaces of the relay.

P115/EN VH Firmware and Service Manual Version History

History of all hardware and software releases for the product.

2. INTRODUCTION TO MiCOM

MiCOM is a comprehensive solution capable of meeting all electricity supply requirements. It comprises a range of components, systems and services from Schneider Electric.

Central to the MiCOM concept is flexibility.

MiCOM provides the ability to define an application solution and, through extensive communication capabilities, integrate it with your power supply control system.

The components within MiCOM are:

- P range protection relays;
- C range control products;
- M range measurement products for accurate metering and monitoring;
- S range versatile PC support and substation control packages.

MiCOM products include extensive facilities for recording information on the state and behaviour of the power system using disturbance and fault records. They can also provide measurements of the system at regular intervals for a control center enabling remote monitoring and control to take place.

For up-to-date information on any MiCOM product, visit our website:

www.schneider-electric.com

3. PRODUCT SCOPE

P115 is a 3 phase and earth fault non-directional overcurrent CT-powered and/or auxiliary voltage powered protection relay (depends on the ordering option. Refer to chapter 3.3)

The scope of P115 applications covers:

- industry and distribution MV networks;
- back-up protection in HV applications,

The relay protects one, two or three-phase applications against earth fault and phase-to-phase short-circuit faults. It was especially developed for compact MV switchboards with circuit breakers. Thanks to a built-in USB port, fault records, events and relay settings can be downloaded to a local PC.

Settings of the protection elements are made using the front panel keyboard, with verification via the display or using MiCOM S1 setting software.

3.1 Key for the manual

P115 relays are available with different hardware versions: number of outputs, type of a case, different rated currents (1A or 5A), auxiliary voltage ranges, communication protocols, etc.

Please refer to the commercial publication for further information on the product features and application arrangements.

3.2 Functional overview

The P115 relay offers a wide variety of protection functions.
The protection features are summarized below:

PROTECTION FUNCTIONS OVERVIEW	
50/51	Three non-directional overcurrent stages are provided for each phase. The first (I>) and the second stage (I>>) may be set to Inverse Definite Minimum Time (IDMT) or Definite Time (DT); the third stage (I>>>) may be set to DT only.
50N/51N	Two non-directional overcurrent stages are provided. The first stage (IN>) may be set to Inverse Definite Minimum Time (IDMT) or Definite Time (DT); the second stage (IN>>) may be set to DT only.
46	Asymmetry overcurrent stage is provided with Definite Time (DT)

The P115 also offers the following relay management functions in addition to the functions listed above.

- Up to 5 last Fault Records and 100 Events available via the USB port or rear optional communication port (RS485)
- Readout of actual settings available via the USB port or rear communication port (RS485)
- Control of CB via a rear communication port (RS485) or the front panel
- Two binary inputs
- External trip function via binary input
- Up to 4 output contacts (ordering option)
- Energy output for CB low energy coil (ordering option)

- Energy output for Flag Indicator
- 3 phase current inputs
- Earth fault current input
- Circuit Breaker Fail (CBF) function
- Start and trip counters

Application overview

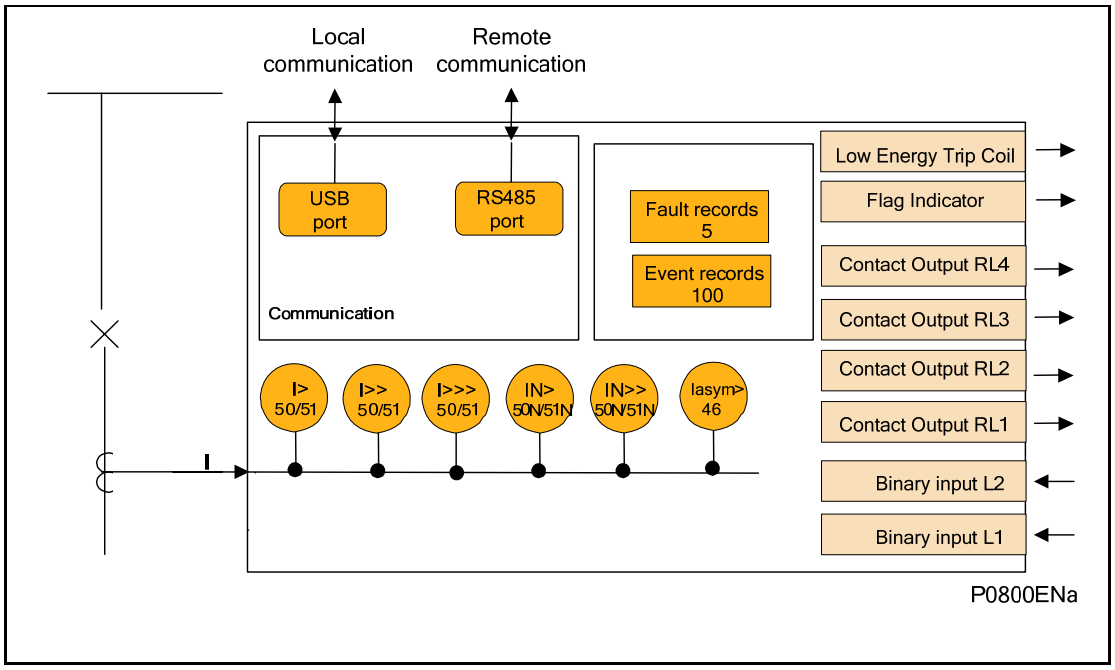

Figure 1: Functional diagram of P115 with all ordering options included

IT

3.3 Ordering options

Information Required with Order

Relay Type	P115	746								
Number of output contacts										
2 c/o contacts			0							
4 c/o contacts			1							
Energy output for CB trip										
Without				0						
Low energy CB coil: 24VDC, 0.1J				1						
Low energy CB coil: 12VDC, 0.02J				2						
Type of the case										
Wall mounting					0					
Flush mounting					1					
Rear communication port (RS485)										
Without						0				
RS485, Switchable protocol: Modbus RTU/IEC103 (Vx and CT powering only)						1				
Auxiliary voltage Vx range (Vx: common for auxiliary supply voltage and binary inputs)										
Vx and CT powering;	Vx= 60-240VAC/60-250VDC						0			
Vx and CT powering;	Vx= 24-48AC/DC						1			
CT powering only;	Vx= 60-240VAC/60-250VDC						2			
CT powering only;	Vx= 24-48VAC/DC						3			
E/F nominal current, setting range (Setting range given for DT characteristic, for IDMT refer to technical data chapter)										
Ien=1A, settings: 0.01 – 2 Ien								0		
Ien=1A, settings: 0.05 – 10 Ien								1		
Ien=1A, settings: 0.2 – 40 Ien								2		
Ien=5A, settings: 0.01 – 2 Ien								3		
Ien=5A, settings: 0.05 – 10 Ien								4		
Ien=5A, settings: 0.2 – 40 Ien								5		
Phase nominal current, setting range (Setting range given for DT characteristic, for IDMT refer to technical data chapter)										
In=1A, settings: 0.2 – 40 In									0	
In=5A, settings: 0.2 – 40 In									1	
Languages										
English/Polish/German/French/Spanish										1
English/Czech/Slovak/Hungarian/Turkish										2

TD

TECHNICAL DATA

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

TD

Technical Data

Mechanical Specifications

Design
Wall mounting case or flush mounting case.

Enclosure Protection
EN 60529: 1991
IP 40 Protection for relay housing
IP 20 Protection for terminals.
IP 52 Protection (front panel) against dust and dripping water for flash mounted case.

Weight
approx. 1 kg

Terminals

AC Current Input Terminals

Threaded M3 screw-type plug-in terminals, with wire protection for conductor cross-section
(i) 0.2 - 6 mm^2 single-core
(ii) 0.2 - 4 mm^2 finely stranded

General Input/Output Terminals

For power supply, binary and contact inputs, output contacts and COM for rear communications.

Threaded M3 screw-type plug-in terminals, with wire protection for conductor cross-section
(i) 0.2 - 4 mm^2 single-core
(ii) 0.2 - 2.5 mm^2 finely stranded

Local communication

USB port
Cable Type: USB 2.0
Connectors:
(i) PC: type A male
(ii) P115: type mini B male

Rear Communications Port

EIA(RS)485 signal levels, two wire
Connections located on general purpose block, M3 screw
For screened twisted pair cable, distance to be bridged: multi-endpoint link: max. 100 m
Isolation to SELV level.

Ratings

AC Measuring Inputs

Nominal frequency of fundamental harmonic: (f_n): 50 to 60 Hz
Operating range of fundamental harmonic: 40 to 70 Hz

Connection: refer to section 12 of P115 Installation chapter (P115/EN IN)

Phase current

Nominal current (In): 1 or 5 A (ordering option)
RMS measurement in range: 40 Hz -1 kHz

Nominal burden per phase:
In=1A: < 2.5 VA at In
In=5A: < 3 VA at In
Thermal withstand:
Continuous 3 In
for 10 s: 30 In
for 1 s; 100 In

Earth fault current

Nominal current (Ien): 1 or 5 A (ordering option)
RMS measurement in range:
40 Hz -70 Hz

Nominal burden:
In=1A: < 2.5 VA at Ien
In=5A: < 3 VA at Ien
Thermal withstand:
Continuous: 3 Ien
for 10 s: 30 Ien
for 1 s: 100 Ien

Minimum level of current required for relay powering

Phase current <0.2In, approx.:
- one phase: 0.17 In
- two phases: 0.1 In
- three phases: 0.06 In

Earth fault current: <0.2 Ien, approx. 0.17 Ien
Note: depends on connection to the terminals, the earth fault input supplies P115 (connection: terminals 7 and 9) or does not supply P115 (connection: terminals 8 and 9) (refer to Installation chapter: P115/EN IN)
Note: if the sum of the currents (which power the P115) is below 0.5In (example of sum equal to 0.5In= Ia: 0.25In + Ib: 0.25In+ Ic: 0In + IN: 0Ien) the LED indications, the display and the RS485 comms are switched off. RL2, RL3, RL4 are not energized. Depending on the setting, the earth current is included or not in the above sum (refer to Settings chapter: P115/EN ST).

TD

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Power Supply

Nominal Auxiliary Voltage Vx
Two ordering options:
(i) Vx: 24 to 48 Vdc, and 24 to 48 Vac (50/60 Hz)

(ii) Vx: 60 to 250 Vdc, and 60 to 240 Vac (50/60 Hz)

Operating Range
(i) 19 to 58 V (dc), 19 to 53V (ac)
(ii) 48 to 300 V (dc), 48 to 265 V (ac)
With a tolerable ac ripple of up to 12% for a dc supply, per IEC 60255-11: 1979.

Nominal Burden
Auxiliary Power Supply Vx
Note:
(i) Initial position: no output nor LED energized.
(ii) Active position: all outputs and LEDs energized.
(i) for ac max. approx.:

	Vx	S	
	V	VA	
		Initial position	Active position
24-48Vac	24	3.1	5.5
	48	2.4	6.0
60-240Vac	48	2.6	5.5
	60	2.7	5.2
	100/110	3.1	5.7
	220/230	5.1	7.4
	264	6.1	8.4

(ii) for dc Vx voltage (24-48Vdc and 60-250Vdc) max. approx:
Initial position: 1.5W
Active position: 3.7W

Power-up Time for Auxiliary Supply Voltage only
Time to power up via auxiliary supply only (not powered by CT): < 0.04 s.

Auxiliary Power Supply Voltage Interruption (without powering by CT)
IEC 60255-11: 1979
The relay will withstand a 50 ms interruption of the DC auxiliary supply within the auxiliary supply range, without de-energizing.
EN 61000-4-11: 1997
The relay will withstand a 50 ms interruption in an AC auxiliary supply, without de-energizing.

Current transformer

Detailed information and CT requirements are given in the Application chapter (P115/EN AP)

Binary Inputs

The binary inputs can be powered with both DC and AC voltage as binary input control voltage

Binary input type: Optically isolated

Rated nominal voltage: the same as Vx
Operating range: the same as Vx
Withstand: 300 Vdc or 275 Vac

Nominal pick-up and reset thresholds:
(i) for DC:
- Vx=24-48Vac/dc:
  - Pick-up: approx. 12 Vdc
  - Reset: approx. 11 Vdc
- Vx=60-240Vac/dc:
  - Pick-up: approx. 21 Vdc
  - Reset: approx. 20 Vdc

(ii) for AC:
- Vx=24-48Vac/dc:
  - Pick-up: approx. 16 Vac
  - Reset: approx. 11 Vac
- Vx=60-240Vac/dc:
  - Pick-up: approx. 26 Vac
  - Reset: approx. 19 Vac

Recognition time: <20 ms

Energy consumption of binary inputs:
Resistance of binary inputs:
(i) 24 to 48 Vac/dc: 5,5kΩ ±5%
(ii) 60 to 240 Vac/dc: 100kΩ ±5%
For 220Vdc: $(220Vdc)^2$ x 100kΩ±5% = 0.484W±5%

Outputs

Impulse Output for the tripping coil (ordering option)

Trip energy:
- Hardware version P115746x1xxxxxx:
  E ≥ 0.1 J, 24 Vdc -0% to +10%
- Hardware version P115746x2xxxxxx::
  E ≥ 0.02 J, 12 Vdc -0% to +10%

Impulse Output for flag indicator or auxiliary relay

Trip energy: E ≥ 0.01 J
Voltage: 24 Vdc -0% to +10%

Note: The tripping energy for the tripping coil/flag indicator is stored by a capacitor built into the protection relay. The capacitors are loaded by a current or the auxiliary voltage. The duration of the trip pulse is 50 ms. The pause between the individual pulses depends on the impedance of the tripping coil/flag indicator coil/flag indicator and on the current level. The pulse lasts as long as the activation threshold is exceeded.

Output Contacts
General purpose relay outputs for signaling, tripping and alarming:
Rated voltage: 250 V
Continuous current: 5 A
Short-duration current: 25 A for 3 s
Making capacity: 150 A for 30 ms
Breaking capacity:
DC: 50 W resistive
DC: 25 W inductive (L/R = 40 ms)
AC: 1250 VA resistive (cos ϕ = unity)
AC: 1250 VA inductive (cos ϕ = 0.7)
Response to command: < 10 ms
Durability:
Loaded contact: 10 000 operations minimum,
Unloaded contact: 100 000 operations minimum.

Environmental Conditions

Ambient Temperature Range
EN 60255-6: 1994
Operating temperature range:
-20°C to +60°C (or -4°F to +140°F).
Temporary permissible temperature -40°C to +85°C (-85°F to +185°F) with additional errors
Storage and transit:
-25°C to +70°C (or -13°F to +158°F).

Ambient Humidity Range
IEC 60068-2-78: 2001:
56 days at 93% relative humidity and +40°C
Per EN 60068-2-30: 2005:
Damp heat cyclic, six (12 + 12) hour cycles, 93% RH, +25 to +55°C

Type Tests

Insulation
EN 60255-5: 2001
Insulation resistance > 100MΩ at 500 Vdc (Using only electronic/brushless insulation tester).

Creepage Distances and Clearances
EN 60255-27:2005
Pollution degree 2,
Overvoltage category III,
Impulse test voltage 5 kV.

High Voltage (Dielectric) Withstand
EN 60255-27:2005, 2 kV r ms AC, 1 minute:
Between all case terminals connected together, and the case earth.
Between all terminals of independent circuits with terminals on each independent circuit connected together.

Impulse Voltage Withstand Test
EN 60255-27:2005,
Front time: 1.2 µs, Time to half-value: 50 µs,
Peak value: 5 kV
Source Characteristics: 500 Ohm, 0.5J.
Common and differential mode - power supply, terminal block (excluding RS485), binary inputs, relays.

Electromagnetic Compatibility (EMC)

1 MHz Burst High Frequency Disturbance Test
IEC 60255-22-1: 2005, Class III,
Common-mode test voltage: 2.5 kV,
Differential test voltage: 1.0 kV,
Test duration: 2s, Source impedance: 200Ω

Immunity to Electrostatic Discharge
IEC 60255-22-2: 1996, Class 3,
8kV discharge in air to all communication ports.
6kV point contact discharge to any part of the front of the product.

Electrical Fast Transient or Burst Requirements
EN 60255-22-4: 2002. Test severity Class III:
Amplitude: 2 kV, burst frequency 5 kHz (Class III),

Surge Immunity Test
EN60255-22-5:2002; EN 61000-4-5: 2006
Level 3,
Time to half-value: 1.2/50 µs,
Amplitude: 2kV between all groups and case earth,
Amplitude: 1kV between terminals of each group.

Immunity to Radiated Electromagnetic Energy
EN 60255-22-3: 2000, Class III:
Test field strength, frequency band 80 to 1000 MHz:
10 V/m,
Test using AM: 1 kHz / 80%,

Radiated Immunity from Digital Radio Telephones
EN 60255-22-3:2000
10 V/m, 900 MHz 100% AM, 200 Hz/50% square wave

Immunity to Conducted Disturbances Induced by Radio Frequency Fields
EN 61000-4-6: 1996, Level 3,
Disturbing test voltage: 10 V, 150 Hz to 80 MHz, 80% AM, 1 kHz

TD

Power Frequency Magnetic Field Immunity
IEC 61000-4-8: 1994, Level 4,
30 A/m applied continuously,
300 A/m applied for 3 s.

Conducted Emissions
EN 55022: 2006
0.15 - 0.5 MHz, 79 dBμV (quasi peak)
66 dBμV (average)
0.5 - 30 MHz, 73 dBμV (quasi peak)
60 dBμV (average).

Radiated Emissions
EN 55022: 2006
30 - 230 MHz, 40 dBμV/m at 10 m measurement distance
230 - 1 GHz, 47 dBμV/m at 10 m measurement distance.

TD

EU Directives

EMC Compliance
2004/106/EC:
Compliance to the European Commission Directive on EMC is claimed. Product Specific Standards were used to establish conformity:
EN50263: 2000

Product Safety
2006/95/EC:
Compliance with European Commission Low Voltage Directive.
Compliance is demonstrated by reference to product safety standard:

EN60255-27:2005

Mechanical Robustness

Vibration Test
EN 60255-21-1: 1996
Response Class 1
Endurance Class 1

Shock and Bump
EN 60255-21-2: 1996
Shock response Class 1
Shock withstand Class 1
Bump Class 1

Protection Functions

Note: All settings and measurements are given as a multiple of the In (Ien) current value (ordering option)

Operation time
The typical operation time, if the P115 is supplied from Vx or if the current is above 0.2 In (Ien): ≤ 40ms

If the pre-fault current is below 0.2 In (Ien) in all phases and that there is no Vx on the 11 -12 terminals, additional time correction should be applied for the operation time (measured on the outputs contacts):

(i) Hardware ver. **P115746x0xxxxxx** (without energy output for low energy tripping coil) for all types of fault (1, 2, 3-phases): ≤ 25mA, except 1-phase fault, where the current is below 1.6 In (Ien) ≤ 30mA,

(ii) Hardware ver. **P115746x1xxxxxx** (with energy output for low energy tripping coil 24VDC 0.1Ws) and **P115746x2xxxxxx** (with energy output for low energy tripping coil 12VDC 0.02Ws):
- for faults where the current is ≤ 0.6 In (Ien):
  1-phase fault: ≤ 60ms
  2-phase fault: ≤ 60ms
  3-phase fault: ≤ 30ms
- for all types of fault where the current is > 0.6 In (Ien) (1, 2, 3-phases): ≤ 30ms

The correction time measured on energy outputs is 6ms shorter than that measured on output contacts.

Note: The tripping time in case of a fault if the pre-fault current is below 0.2 In and there is no auxiliary voltage (Vx) on terminals 11 -12 is the sum of the set time delay, the operation time and the correction time (see above).

Protection Accuracy

Note:

1. All data below are given for inception of fault from currents above 0.2 In (Ien) at least in 1 phase or if the P115 is powered from the Vx auxiliary voltage supply.
   If the pre-fault current is below 0.2 In (Ien) in all phases and that there is no Vx on terminals 11 -12 additional time correction should be taken into account (see above)

2. Reference Conditions:
   Sinusoidal signals with nominal frequency f_n, total harmonic distortion ≤ 2 %, ambient temperature 20 °C and nominal auxiliary voltage Vx

Three-Phase Overcurrent I>, I>>
(i) Pick-up: Setting ±5%
in the temperature range -20°C to +60°C
(ii) Pick-up: Setting ±7.5%
in the temperature range -40°C to +85°C

Drop-off: 0.95 x setting ±5%
Minimum IDMT level:
1.05 x setting ±5%
IDMT curve: ±7.5% or 30 ms whichever is greater
DT operation: ±2% or 30 ms, whichever is greater
DT reset: ±7.5% or 30 ms, whichever is greater

Three-Phase Overcurrent I>>>
(i) Pick-up: Setting ±5%
in the temperature range -20°C to +60°C
(ii) Pick-up: Setting ±7.5%
in the temperature range -40°C to +85°C

Drop-off: 0.95 x setting ±5%
DT operation: ±2% or 30 ms, whichever is greater
DT reset: ±7.5% or 30 ms, whichever is greater

Earth Fault IN>
(i) Pick-up: Setting ±5%
in the temperature range -20°C to +60°C

(ii) Pick-up: Setting ±7.5%
in the temperature range -40°C to +85°C

Drop-off: 0.95 x setting ±5%
Minimum IDMT level:
1.05 x setting ±5%
IDMT curve: ±7.5% or 30 ms whichever is greater
DT operation: ±2% or 30 ms, whichever is greater
DT reset: ±7.5% or 30 ms, whichever is greater

Earth Fault IN>>
Pick-up:
(i) Setting ±5%
in the temperature range -20°C to +60°C

(ii) Setting ±7.5%
in the temperature range -40°C to +85°C

DT operation:
±2% or 30 ms whichever is greater

DT reset: ±10% or 30 ms, whichever is greater

Asymmetry Overcurrent Protection

Measurement criteria based on the maximum deviation of the phase current to the average value of the three-phase current

Pick-up:
(i) Setting ±5%
in the temperature range -20°C to +60°C
(ii) Setting ±7.5%
in the temperature range -40°C to +85°C

DT operation:
±2% or 30 ms whichever is greater

DT reset: ±7.5% or 30 ms, whichever is greater

Measured Data Acquisition

Reference Conditions:
Sinusoidal signals with nominal frequency f_n total harmonic distortion ≤2 %, ambient temperature 20 °C and nominal auxiliary voltage Vx.

Deviation relative to the relevant nominal value under reference conditions

Operating Data

For current up to 3 In (Ien):

Phase and earth current:	±3%
Asymmetry current:	±5%

Fault Data

Phase and earth current :

For current ≤ 3 In (Ien):	±5%
For current > 3 In (Ien):	±5% of measured current value

Communications

USB:

USB port for local communications with a PC
Protocol: MODBUS RTU

The virtual COM port for USB comms should be set in as follows:

(i) Address: 1

(ii) Baud Rate*:* 115.2 kbits/s

(iii) Comms. Mode:
Data Bit: 8
Stop bit: 1
Parity: none

RS485:

Protocol (ordering option):
- MODBUS RTU
- IEC 103

Physical Link: Copper; RS485 half duplex

Comms. Mode:
Data Bits: 8
Stop bit: 1 or 2 (default: 1)
Parity: no parity/Odd parity/Even parity (default: Even parity)
Address: 1 to 127 (default: 1)
Baud Rate*:* 4.8 kbits/s to 115.2 kbits/s (default: 19.2 kbit/s)

TD

Settings, Measurements and Records List

Settings

Phase Overcurrent

I>, I>> Function:

DT, TD time-delay:
0.02 s to 200 s; steps: 0.01 s,

TMS: 0.02 s to 1.6 s: steps: 0.01 s

Type of characteristics:
(i) DT
(ii) IEC S Inverse
(iii) IEC V Inverse
(iv) IEC E Inverse
(iii) UK LT Inverse
(iv) RC
(vi) RI
(vii) UK ST Inverse
(viii) UK Rectifier Inverse
(ix) IEEE M Inverse
(x) IEEE V Inverse
(xi) IEEE E Inverse
(xii) US CO2
(xiii) US CO8

The mathematical formulae and curves for the twelve Inverse Time characteristics available with the P115 are presented in the Operation chapter (P115/EN OP) of this manual.

IDMT accuracy is ensured up to 20 x In

Reset time:
- DT delayed
- IDMT delayed for IEEE, US, IEC stages only: according to the mathematical formulae presented in Operation chapter (P115 EN OP) of this manual

I>, I>> Current Set: 0.2 to 4 In steps: 0.01 In

I>>> Function:

Type of characteristic: DT

DT time delay: 0.00 s to 200 s; steps: 0.01 s

I>>> Current Set: 0.2 to 40 In steps: 0.01 In

Ground Overcurrent (Earth Fault)

Stages:
IN> Function:

DT, TD time delay:
0.00 s to 200 s; steps: 0.01 s,

TMS: 0.02 s to 1.6 s: steps: 0.01 s

Type of characteristic:
(i) DT
(ii) IEC S Inverse
(iii) IEC V Inverse
(iv) IEC E Inverse
(v) UK LT Inverse
(vi) RC
(vi) RI
(xiv) UK ST Inverse
(xv) UK Rectifier Inverse
(xvi) IEEE M Inverse
(xvii) IEEE V Inverse
(xviii) IEEE E Inverse
(xix) US CO2
(xx) US CO8

The mathematical formulae and curves for the twelve Inverse Time characteristics available with the P115 are presented in the Operation chapter (P115/EN OP) of this manual

Reset time:
- DT delayed
- IDMT delayed for IEEE, US, IEC stages only: according to the mathematical formulae presented in Operation chapter (P115 EN OP) of this manual

IN> Current Set (ordering option):
(i) 0.01 to 0.2 Ien step 0.01 Ien
(ii) 0.05 to 1 Ien steps: 0.01 Ien,
(iii) 0.2 to 4 Ien steps: 0.01 Ien,

IDMT accuracy is ensured up to 20 x current setting

IN>> Function:

Type of characteristic: DT

DT time delay: 0.00 s to 200 s steps: 0.01 s

IN>> Current Set:
(i) 0.01 to 2 Ien steps: 0.01 Ien
(ii) 0.05 to 10 Ien steps: 0.01 Ien
(iii) 0.2 to 40 Ien steps: 0.1 Ien

Minimum earth current to supply P115: 0.2 Ien

Asymmetry Overcurrent

Iasym> Function:

Iasym> Current Set: 0.08 to 4 In steps: 0.01 In
DT time delay: 0.02s to 200 s steps: 0.01 s

Circuit Breaker Fail

CB Fail Timer: 0.00 to10.00 s steps: 0.01 s
I< Current Set: 0.05 to 4 In steps: 0.01 In
IN< Current Set: 0.05 to 4 Ien steps: 0.01 Ien,
CBF Prot. Reset: I< and IN<

Measurements List

Measurements

IA, IB, IC, IN

TD

GS

GETTING STARTED

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

GS

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1. GETTING STARTED

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide SFTY/4L M/E11 or later issue, OR the safety and technical data section of the technical manual and also the ratings on the equipment rating label.

For safety reasons, no work must be carried out on the P115 until all power sources to the unit have been disconnected.

1.1 User interfaces and menu structure

The settings and functions of the MiCOM protection relay can be accessed both from the front panel keypad and LCD, and via the front and rear communication ports. Information on each of these methods is given in this section to describe how to start using the relay.

GS

1.2 Introduction to the relay

1.2.1 Front panel

The front panel of the relay is shown in Figure 1.

The front panel of the relay includes:

- a 16-character by 2-line alphanumeric liquid crystal display (LCD)
- a 7-key keypad comprising 4 arrow keys, an enter key, a clear key, a read key,
- 8 LEDs

a USB port for local communication.

1.2.1.1 Indications

Fixed Function LEDS:

Healthy – Powering of microprocessor and no hardware problems detected (green LED)

Trip – Any Trip by protection criteria

And 6 programmable LEDS for the following functions (OR logic):

I> – Start of the first phase overcurrent stage

I>> – Start of the second phase overcurrent stage

I>>>– Start of the third phase overcurrent stage

IN> – Start of the first e/f overcurrent stage

IN>> – Start of the second e/f overcurrent stage

Iasym> – Start of the asymmetry overcurrent stage

AUX1 – Trigger of AUX1 timer (via a binary input)

AUX2 – Trigger of AUX2 timer (via a binary input)

tI> – Trip of the first phase overcurrent stage (flashing: start)

tI>> – Trip of the second phase overcurrent stage (flashing: start)

tI>>> – Trip of the third phase overcurrent stage (flashing: start)

tIN> – Trip of the first e/f overcurrent stage (flashing: start)

tIN>> – Trip of the second e/f overcurrent stage (flashing: start)

tIasym> – Trip of the asymmetry overcurrent stage (flashing: start)

tAUX1 – Time delay tAUX1 elapsed (flashing: start)

tAUX2 – Time delay tAUX1 elapsed (flashing: start)

CBF fail – Trip of Circuit Breaker Failure function

CB ext. – Trigger of external trip

tCB not Healthy – Input configured to this function detects a problem with CB (for example spring problem, too low pressure etc.). Signaling is active after settable time delay (tCB; *GLOBAL SETTINGS/CIRCUIT BREAKER/ tCB not Healthy*)

Setting Group 1 (2) – Setting Group 1 (2) active

Start Phase A – Start of the phase overcurrent stage (set to trip) in phase A

Start Phase B – Start of the phase overcurrent stage (set to trip) in phase B

Start Phase C – Start of the phase overcurrent stage (set to trip) in phase C

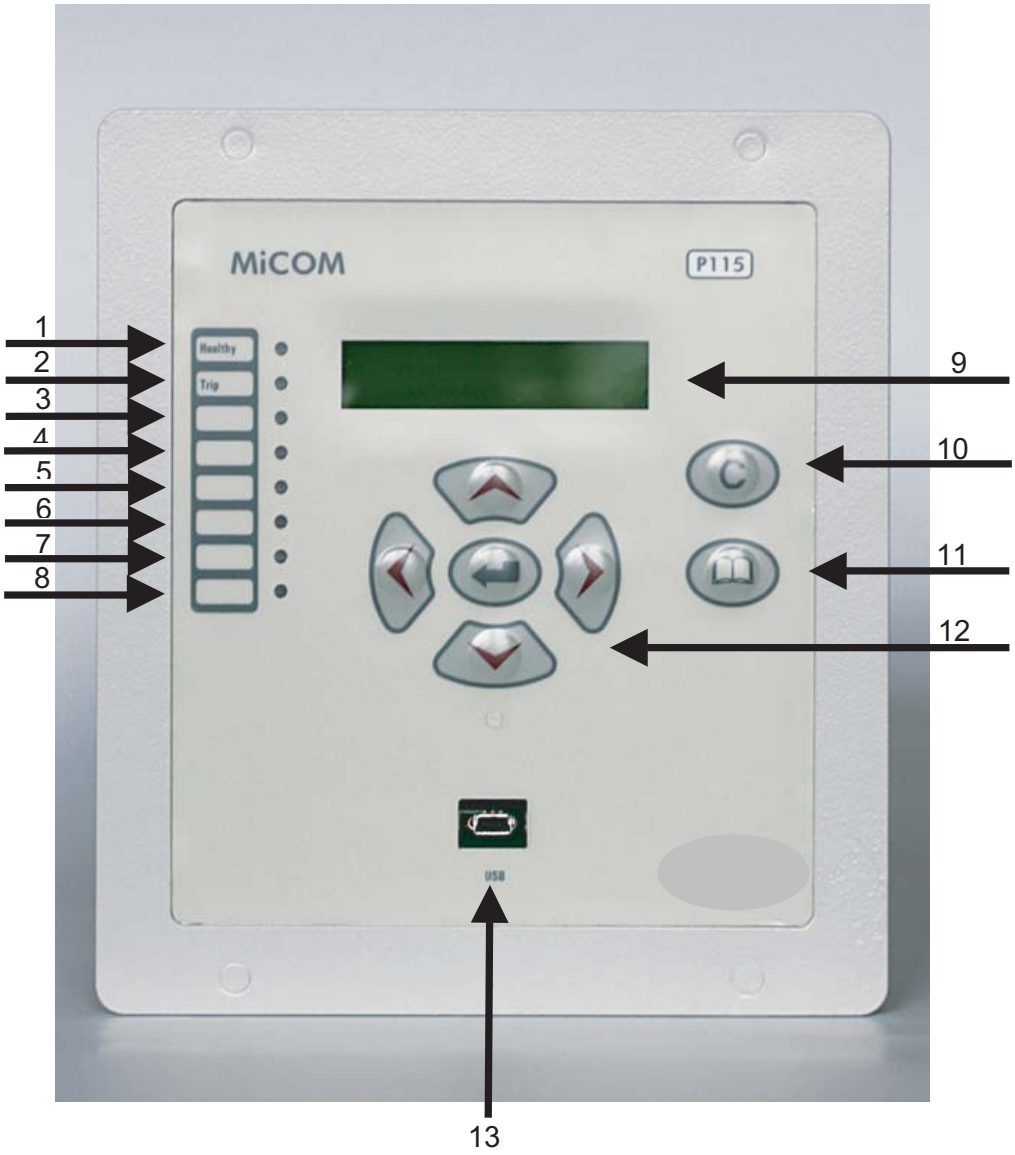
Start Earth – Start of the e/f overcurrent stage (set to trip)

Every LED can be configured to be latching or self-resetting (*SETTING GROUP 1/ LEDS CONFIGURATION G1/ Latched LEDs*)

If LED is configured for latching, the resetting mode can be set:

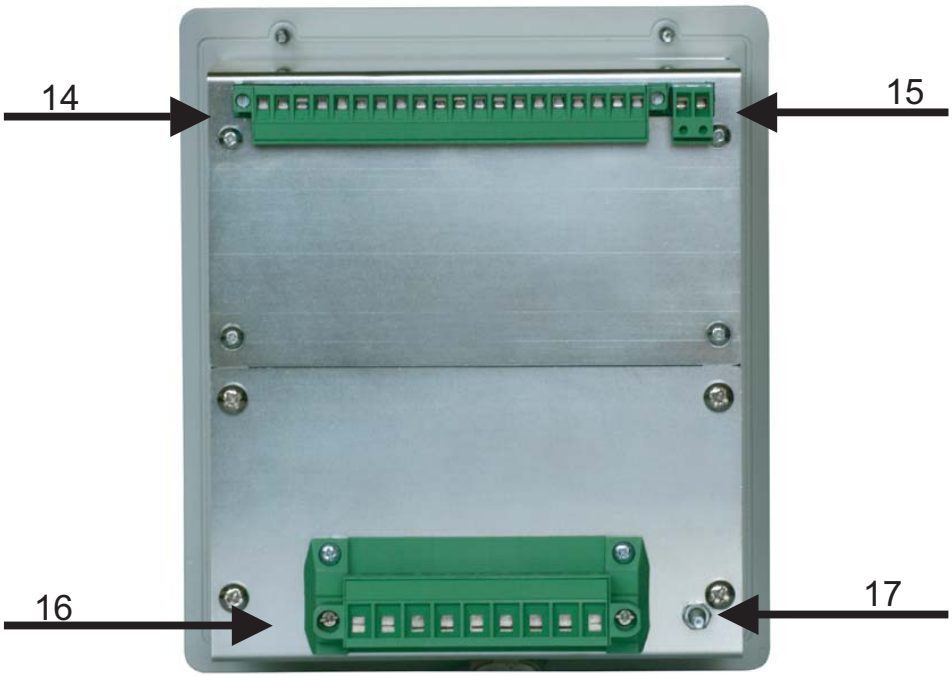
- LEDs reset by manual reset (*GLOBAL SETTINGS/LOC/LEDs Reset by Start 0:No*)
- LEDs reset by any protection start (set for CB tripping) or manual reset (*GLOBAL SETTINGS/LOC/LEDs Reset by Start 1:Yes)*

External indication of a fault can be made via an external Flag Indicator (available in Schneider Electric offer: FI10) which should be connected to terminals 27-28.



1 - Green “Healthy” LED.
2 - Red “Trip” LED Any trip of protection
3, 4, 5, 6, 7, 8 - Red programmable LED.
9 - 16-character by 2-line alphanumeric liquid crystal display (LCD)
10 - A clear key
11 - A read key,
12 - 4 arrow keys, an enter key
13 - USB port for local connection

Figure 1: P115 front panel



14 - 3rd terminal block: Auxiliary voltage supply, Binary inputs, Binary outputs, Flag indicator energy output, Low energy trip coil,
15 - 2nd terminal block: RS485
16 - 1st terminal block: phase and e/f current inputs
17 - PCT Protective (Earth) Conductor terminal

Figure 2: Rear view of the P115

1.3 Relay connection and power-up

The relay can be powered from the following sources:

- Current input phase L1 (A)
- Current input phase L2 (B)
- Current input phase L3 (C)
- E/F Current input (N) (depends on connection on the terminals)
- Auxiliary voltage Vx (terminals 11-12)
- USB port (some electronic boards only, to ensure HMI, USB and/or RS485 communication only)

1.3.1 Auxiliary Supply Voltage (Vx) connection

Before applying the auxiliary supply voltage to the relay, check that the rated nominal ac or dc voltage is appropriate for the application and that it will be connected to the correct terminals (11&12). The relay's serial number, current rating, and power rating information can be viewed on the upper side of the case. The ac or dc supply voltage must be within the corresponding nominal range of the device, as indicated in the table below, for the appropriate nominal rating of the equipment:

Nominal ranges of auxiliary voltage Vx	Operative dc Range	Operative ac Range
24 to 48 Vac/dc	19 to 58 Vdc	19 to 53 Vac
60 to 250 Vdc and 60 to 240 Vac	48 to 300 Vdc	48 to 265 Vac

Once the ratings have been verified for the application, connect the equipment to an external power source capable of delivering the requirements specified on the label, to perform the relay familiarization procedures. Please refer to the wiring diagrams in the Installation section for complete installation details, ensuring that the correct polarities are observed in the case of dc supply.

Note: The label specifies Vx for both the P115 supply input and binary inputs.

1.3.2 Current inputs

The measuring current inputs of the P115 should be connected to the secondary wires of the power system CTs as shown in the connection diagrams in section 8 of P115 Installation chapter P115/EN IN.

The parameters of the CTs which can be connected to the P115's current input terminals are detailed in section 3 of chapter P115/EN AP - Applications.

1.3.3 Tripping coil output (ordering option)

Terminals 29 and 30 (3rd block terminal) are used for the connection of the CB's low energy tripping coil (ordering option)

The trip energy is provided by capacitors built into the P115. The trip command is a 50 ms pulse and its repetition depends on the tripping coil's impedance and on the current value. Repetition continues until the tripping current criteria are reset.

The trip voltage on terminals 29 and 30 depends on the ordering option:

- 24 Vdc, trip energy $\geq$ 0.1 Ws
- 12 Vdc, trip energy $\geq$ 0.02 Ws

1.3.4 Flag indicator output

Terminals 27 and 28 (3rd block terminal) are used for the connection of an external flag indicator.

The flag indicator can be used for trip signaling. The flag indicator output is supplied from a built -in capacitor different from the trip coil output (terminals 29 and 30).

The trip command is a 50ms pulse, its repetition depends on the external relay's impedance (flag indicator coil) and on the current value. Repetition continues until the tripping current criteria are reset.

The voltage on terminals 27 and 28 is greater than 24 Vdc. The trip energy is greater than 0.01 Ws.

1.3.5 Earthing

Terminal “PCT” is the Protective (Earth) Conductor Terminal which must be permanently connected for safety reasons (refer to Figure 2).

1.3.6 Output contacts

P115 has 2 or 4 output contacts depending on ordering option.

P115 is delivered with the following default factory settings for outputs:

- output RL1 (N/O: 16-17, N/C: terminals 16-18) is configured to Protection Trip, without latching of output
- output RL2 (N/O: 19-20, N/C: terminals 19-21) is not configured
- output RL3 (N/O: terminals 22-23) (optional) is not configured.
- output RL4 (N/O: 24-25 terminals) (optional) is not configured.

To change the output configuration refer to section 1.2.3 of chapter P115/EN ST - Settings .

The output connection diagram is shown in section 8 of chapter P115/EN IN - Installation.

1.3.7 Binary inputs

The P115 has 2 binary inputs: L1 (terminals 13-15) and L2 (terminals 14-15)

The P115 is delivered with the following default factory settings for inputs:

- input L1 is not configured.
- input L2 is not configured.

To change input configuration refer to section 1.2.3 of chapter P115/EN ST - Settings.

The input connection diagram is shown in section 8 of chapter P115/EN IN - Installation.

1.4 Introduction to the user interfaces and settings options

The relay has a USB user interface for MiCOM S1 software.

By using this interface it is possible to download the setting values, last 5 fault records and make a full configuration of P115

NOTE: After connection to the USB port the “Healthy” LED is lit. If the LED is not lit refer to chapter P115/EN TS - Troubleshooting.

The USB port integrates electronic boards only to allow communications with the P115 via the HMI/RS485/USB interfaces.

1.5 Changing parameters via the front panel.

Changing of all parameters is password-protected.

After restart or applying of power supply, the P115 is in *Protection Mode*. This means that all settings are the same as in the relay's operation system and are available on the front panel.

To change any parameters, it is necessary to switch the P115 to the *SETTING CHANGE MODE.*

The SETTING CHANGE MODE is indicated by the sequential flashing of the programmable LEDs (from 3 up to 8 LEDs) on the front panel.

Until it is switched back from the *SETTING CHANGE MODE* to the *PROTECTION MODE,* or restarted by disconnecting then reconnecting the power supply, the P115 uses the setting parameters that were active before the *SETTING CHANGE MODE was entered* (previous settings).

Press the *ENTER* key after changing a chosen parameter (confirmation of change). The new value is saved in FRAM memory but the P115 still uses the setting value which was active before the *SETTING CHANGE MODE was entered* (previous settings). The new value will be available in the operation system only after the firmware has been reset. When the firmware is reset, all the settings stored in FRAM memory are loaded into the P115 system.

When switching from the *SETTING CHANGE MODE* to the *PROTECTION MODE, a* warm reset is applied.

The P115 therefore applies the new parameters to the relay's operation system.

Afterwards, the settings available on the front panel those used by the operation system are coherent.

NOTE: While the LEDs are flashing (*SETTING CHANGE MODE*) there can be a mismatch between the settings displayed on the front panel and those used by the operating system.

The password protection of the relay comprises three levels:

- Administrator (*Without limits*)
- Protection setting (*Protection only*)
- Control only (*Test control*)

Administrator rights: all the menu settings may be changed.

Protection setting rights: it is possible to change settings in the PROTECTION column, CB control and reset of the counters are also possible.

Control rights: CB control from the front panel only.

For each level the password consists of 5 digits (0 to 9)

The default password is 00000.

If the first password is different, this means that the ‘Administrator’ password has been changed.

The Protection setting password is still 00000. Therefore, to protect settings against unauthorized access it is necessary to change the *Protection setting* password by first entering 00000 then a new value.

The Control password is still 00000. Therefore, if it is necessary to change it, first enter 00000 then the new value (*Control* right) of the password.

NOTES:

1. If the *Protection setting* rights have not been changed, or if it has been set to the default value (00000), it is possible to change all the settings in the *PROTECTION* column, reset the counters and control the CB without entering a password, simply by pressing the ENTER key. This makes it possible to change a chosen parameter by automatically switching the P115 to the *SETTING CHANGE MODE* (the programmable LEDs are flashing).
   This means that even after changing only one parameter it is necessary to switch the P115 back to *PROTECTION MODE* in order to activate the new settings (warm restart).

2. If the *Control* rights password has not been changed or if it has been set to the default value (00000) it is possible to control the CB or choose the older faults in Fault Record column without password protection.

1.5.1 *SETTING CHANGE MODE*

The SETTING CHANGE MODE should be used to change settings.

Using the SETTING CHANGE MODE ensures that all changed parameters will be applied simultaneously so as to avoid any problems caused by possible setting inconsistencies.

The SETTING CHANGE MODE makes it possible to change settings while the relay is active without any risk (the P115 continues to use the previous settings).

After exiting the *SETTING CHANGE MODE* a warm reset of firmware is applied so that all the protection counters are reset.

NOTE: Latched LEDs and outputs are not reset (stored values are not cleared during a P115 reset)

To switch the P115 to *SETTING CHANGE MODE* navigate to the *SETTING CHANGE MODE* main header (see Figure 9), then press the *DOWN* key:


```
Edit settings?
Enter PSWD
```

Press *ENTER* key

```
Edit settings?
Enter PSWD 00000
```

The 0 digit furthest to the right is flashing.

Enter the password:

1. If the digit is flashing, change the digit to the required value by pressing the *DOWN* key or the *UP* key.
2. Change the flashing digit by pressing the left key or right key.
3. Continue as above to set the whole password (5 digits)
4. If the correct password is set, press the *ENTER* key

The LCD displays 'OK' during approximately 1 second, then the new *SETTING CHANGE* cell is displayed:

If the password entered is for:

- *Administrator* rights:

```
Setting change:
 Without limits
```

- *Protection* settings:

```
Setting change:
 Without limits
```

- *Control* only:

```
Setting change:
 Test control
```

The screen displays the scope of the current modification rights. To indicate that the P115 is in *SETTING CHANGE MODE* the programmable LEDs are flashing.

At this time it is possible to start changing the setting parameters.

NOTE: The parallel pressing: *UP* and *LEFT* key it makes jump from any place to:

```
Edit settings?
 Enter PSWD
```

the menu cell in which the password can be entered (hot key).

If all settings are changed, it is necessary to return to *PROTECTION MODE* to apply a warm reset.

Press the *UP* and *LEFT* keys simultaneously to jump to the following cell:

```
Edit settings?
Exit:press ENTER
```

Press the *ENTER* key to apply a warm reset and display the following cell:

```
Setting change:
       Protected
```

The programmable LEDs do not flash sequentially. The P115 is in *PROTECTION MODE*

NOTE: In *SETTING CHANGE MODE* all functions use the previously stored settings (before the *SETTING CHANGE MODE* was entered).

Changing of a single setting parameter

Go to the required setting cell (see section 1.5.1).

Press the *ENTER* key.

```
Edit settings?
Enter PSWD 00000
```

Using the *LEFT*, *RIGHT*, *UP*, *DOWN* keys, enter the password (see section 1.5.1).

Press *ENTER* to confirm the password and switch to *SETTING CHANGE MODE.*

Press *ENTER* to enter the chosen setting parameter.

Using *the LEFT*, *RIGHT*, *UP*, *DOWN* keys, set the required value.

Confirm the change by pressing the *ENTER* key.

Switch from *SETTING CHANGE MODE* to *PROTECTION MODE* (see section 1.5.1).

For example, press the *LEFT* and *UP* keys simultaneously to display the following cell:

```
Edit settings?
Exit:press ENTER
```

Press the *ENTER* key to switch from *SETTING CHANGE MODE* to *PROTECTION MODE*.

The following cell should be displayed:

```
Setting change:
       Protected
```

The above cell confirms that settings are password-protected, and that the P115 is in *PROTECTION MODE*.

Additionally the programmable LEDs do not flash sequentially.

Changing the password

To change the password, first enter the existing password to obtain the appropriate password protection rights.

Press the *DOWN* key to display the following cell:

```
Change Password
```

Press *the ENTER* key, to display:

```
Change Password
          00000
```

Using the *LEFT*, *RIGHT*, *UP*, *DOWN* keys, enter the new password.

Press *ENTER* to confirm the new password and jump to the cell displaying information on protection rights

For example:

```
Setting change:
 Without limits
```

To exit the *SETTING CHANGE MODE* (apply a warm reset) press the *LEFT* and *UP* keys simultaneously to display the following cell:

```
Edit settings?
Exit:press ENTER
```

Press the *ENTER* key to confirm switching from *SETTING CHANGE MODE* to *PROTECTION MODE.*

The following cell should be displayed:

```
Setting change:
       Protected
```

The above cell confirms that the settings are password-protected and that the P115 is in *PROTECTION MODE.* Additionally the programmable LEDs do not flash sequentially.

1.6 P115 Menu description

1.6.1 Headers

The main headers are shown in Figure 3.

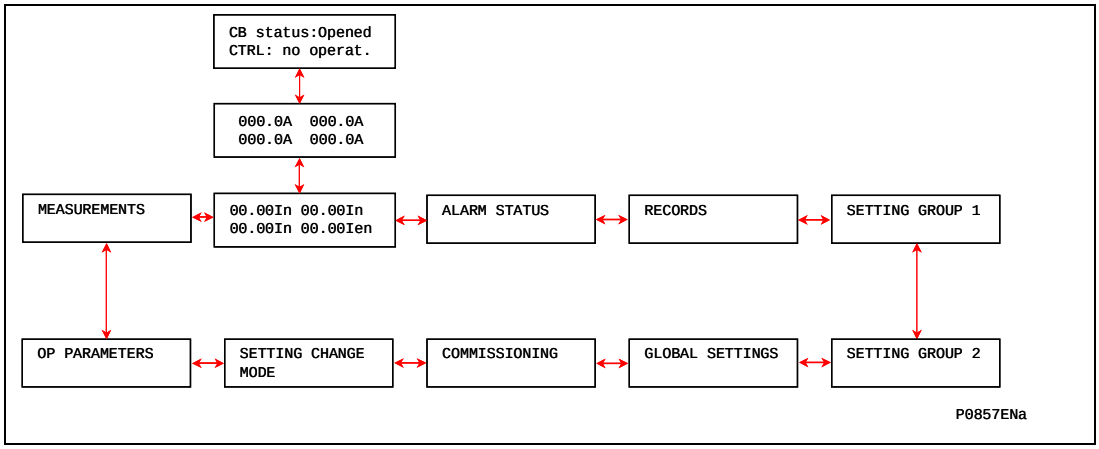


Figure 3: Column headers

1.6.2 ALARM STATUS column

ALARM STATUS (see Figure 4) information is available if the cause of alarm has been triggered. Therefore, if after pressing the *DOWN* key no the new cell is displayed, it means that no alarms have been detected.

Depending on the P115 configuration an alarm signal is self-resetting (no cause of alarm – no alarm signal; *GLOBAL SETTINGS/LOC/Alarm Display 0: Self-Reset*) or manually resettable (alarm signal latched; *GLOBAL SETTINGS/LOC/Alarm Display 1: Manual Reset*).

Default setting: *0: Self-Reset.* This means that if an alarm signal has disappeared no information is available in the *ALARM STATUS* column.

If *Manual Reset* is set, this means that if an alarm signal has disappeared the corresponding information is still available in the *ALARM STATUS* column up until it is reset in the *ALARM STATUS/ Alarm Reset* cell.

Alarm information is always available in the event recorder. However, the programmable LEDs can be used to store causes of alarm if required.

Figure 4 shows all causes of alarms (if alarms have been enabled in the main configuration column of the protection function).

GS

GS

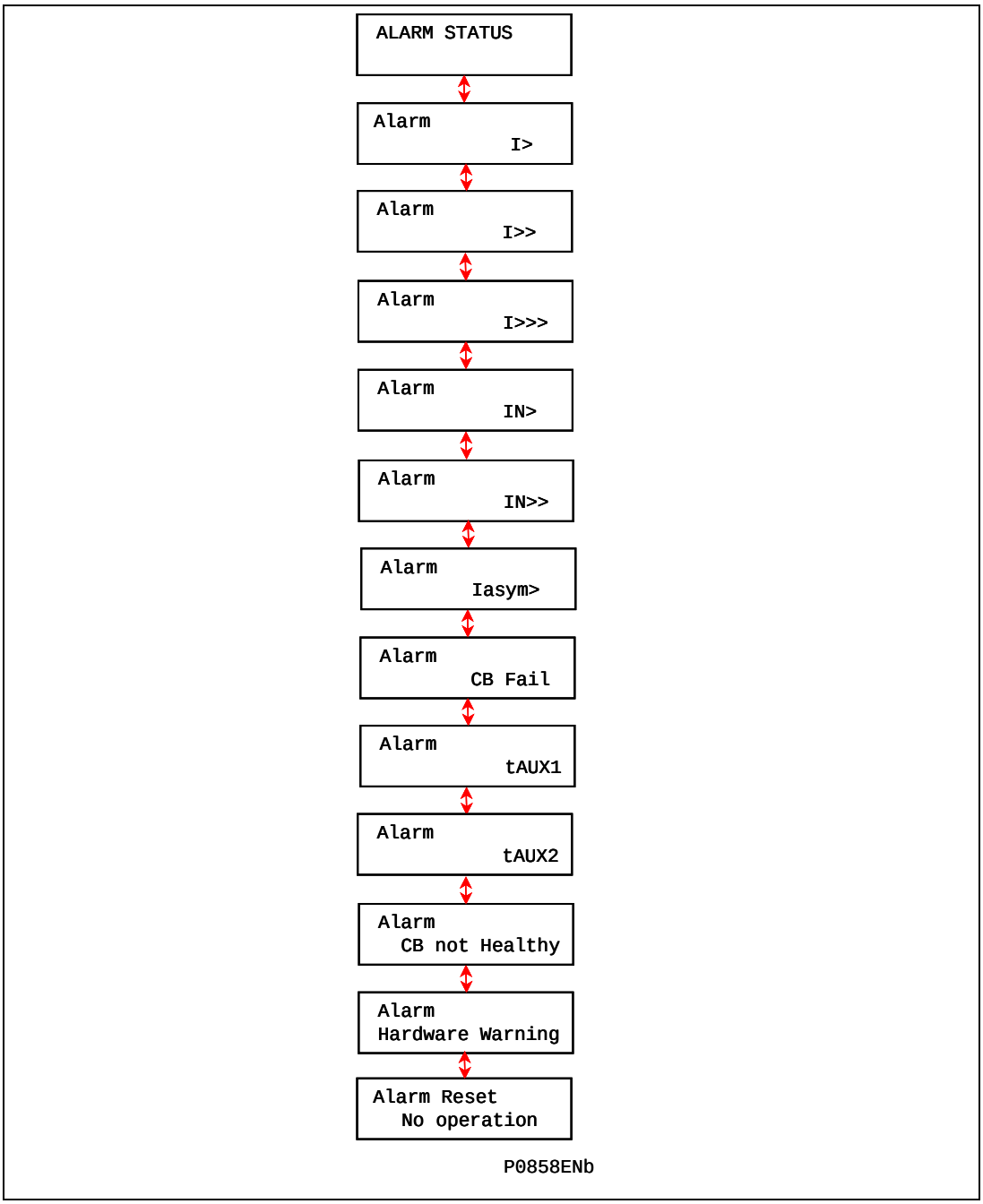


Figure 4: ALARM column

1.6.3 RECORDS column

Five fault records are available in the P115.

Changing a record in the menu is possible in the *Record Nb* menu cell, by pressing the *ENTER* key then the *DOWN* or *UP* key. Once the required record is selected, press the *ENTER* key to confirm the change. If the *Control* rights password has been set to the default value (00000), this operation does not require entering a password, otherwise it is necessary to enter *Control* rights password.

Records in the Fault Recorder can be reset using the MiCOM S1 communication software or via the RS485 link.

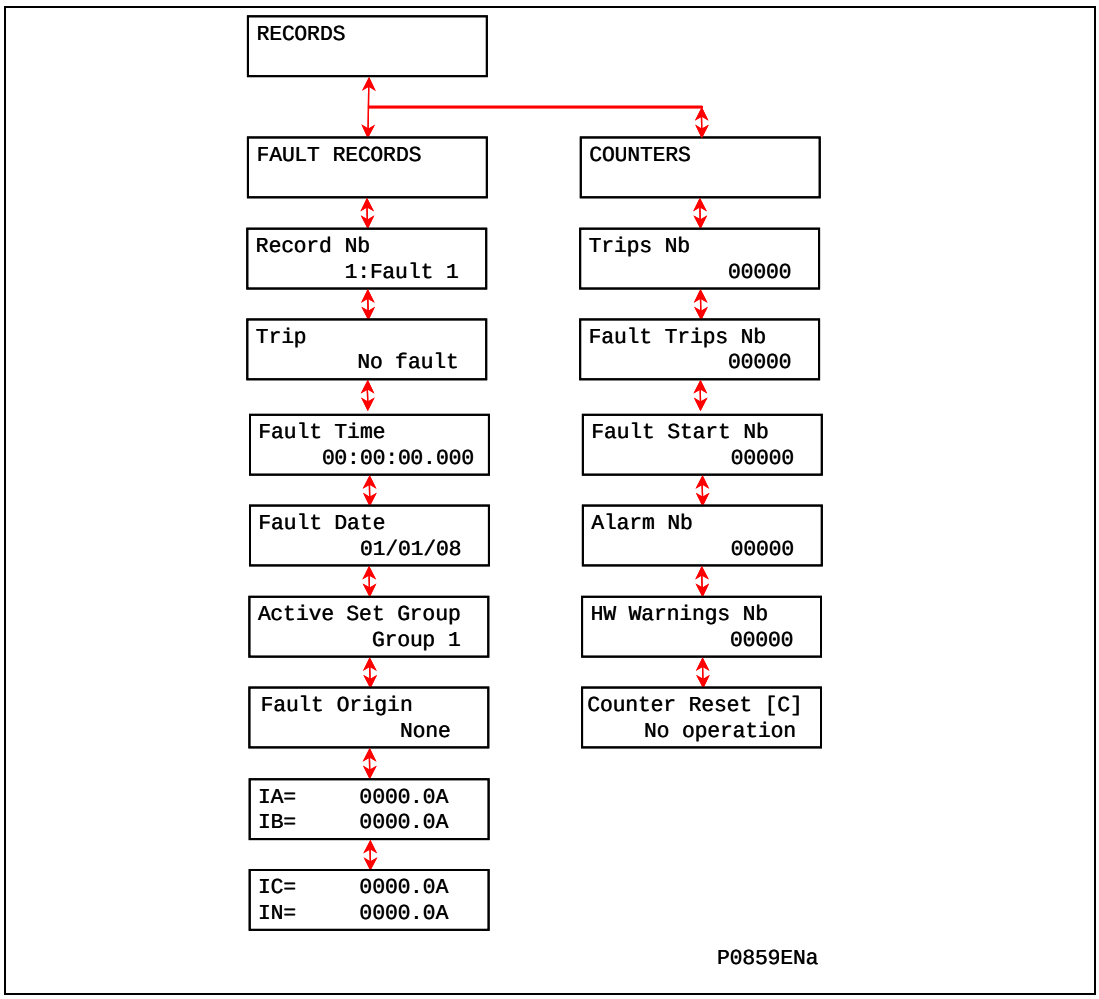


Figure 5: RECORDS column

Counters can be reset in the *Counter Reset* cell of the menu, by pressing the *ENTER* key then the *DOWN* or *UP* key. Once the required record is selected, press the *ENTER* key to confirm the change. This operation requires entering an Administrator password.

In addition, counters can be reset using the MiCOM S1 communication software or via the RS485 link.

1.6.4 SETTTING GROUP columns

The P115 has two setting groups. Each setting group includes:

- Protection settings
- Output relay configuration
- Binary input configuration
- Programmable LED configuration

Switching between setting groups is possible via:

- Configured binary inputs
- Menu (*GLOBAL SETTINGS/SETTING GROUP SELECT/Setting Group Select* cell)
- MiCOM S1 setting software

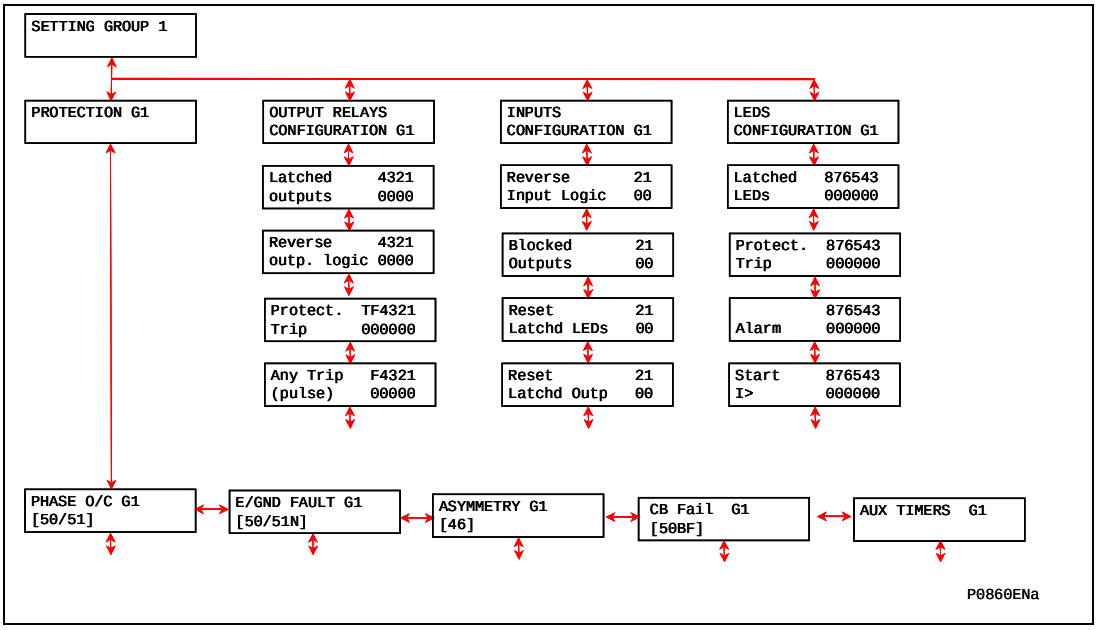


Figure 6: SETTING GROUP 1 columns

Information about the active setting group is available in menu: *OP PARAMETERS/ Active Set Group* cell.

Information about the active setting group can be displayed via the programmable LEDs by configuring them to that function.

NOTES:

1. If setting groups are to be switched using a binary input, this binary input must be configured to setting group switch both in Setting Group 1 and Setting Group 2.
2. It is possible to copy all the parameters from Setting Group 1 to Setting Group 2 or vice versa (*GLOBAL SETTINGS/SETTING GROUP SELECT/Copy Settings* cell). It will then only be necessary to change the parameters' values.

1.6.5 GLOBAL SETTINGS column

Global Settings include all general settings, such as:

- Localization (*LOC*)
- Setting Group operation (*SETTING GROUP SELECT*)
- Current transformer parameters (*CT RATIO*)
- Time settings related to Circuit Breaker control or monitoring (*CIRCUIT BREAKER*)
- RS485 communication parameters (*COMMUNICATION*)

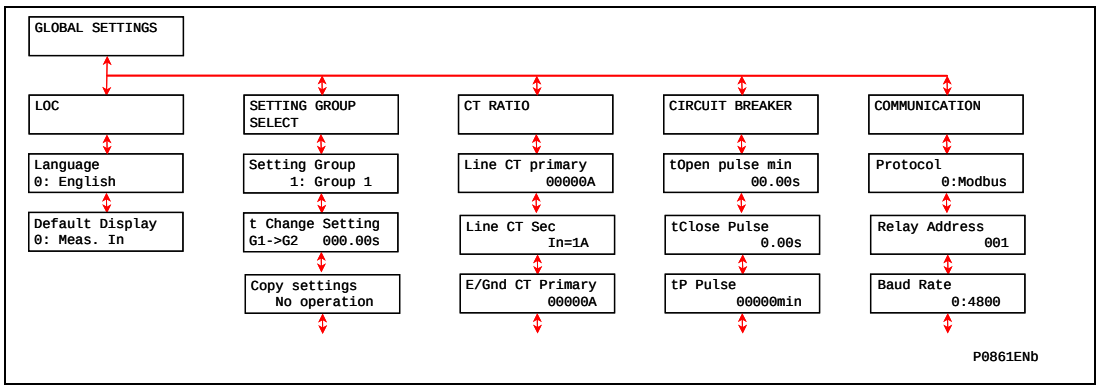


Figure 7: GLOBAL SETTINGS column

It is possible to Copy all parameters from Setting Group 1 to Setting Group 2 and inversely in *Copy settings* cell by pressing the *ENTER* key. Choose the required operation by pressing the UP or DOWN key (Copy G1 → G2 or Copy G2 → G1). Confirm the change by pressing the *ENTER* key.

Note: The setting group change time-delay, from Setting Group 1 to Setting Group 2 (*t Change Setting* cell), applies to changes effected via a binary input only.

1.6.6 COMMISIONING column

In the *COMISSIONING* column displays the active binary input and binary output status.

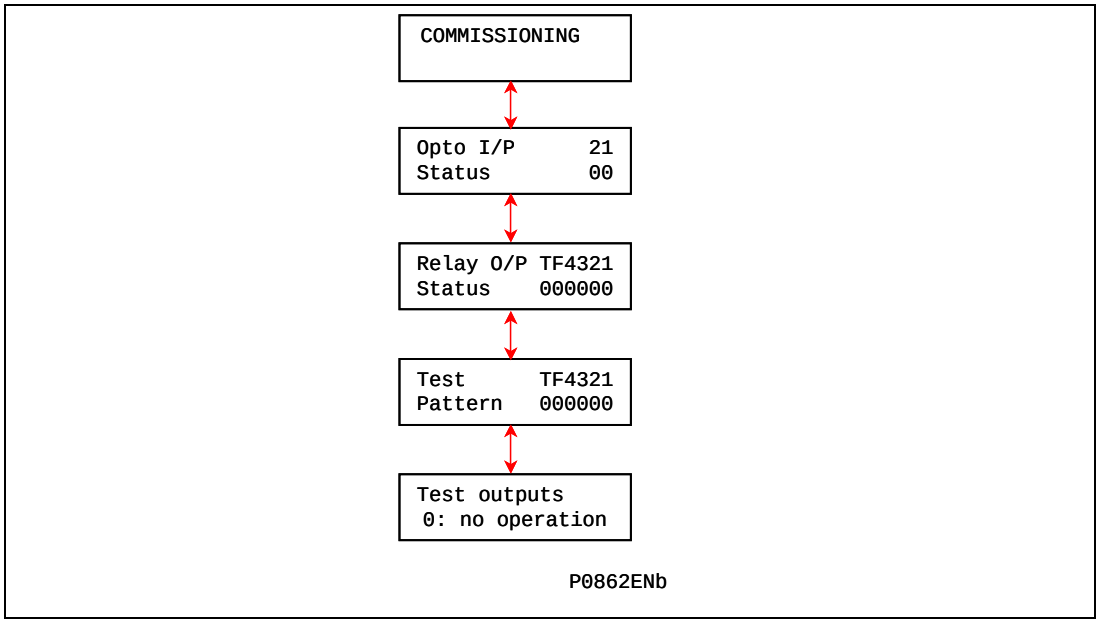


Figure 8: COMMISSIONING column

1.6.7 SETTING CHANGE MODE column

The SETTING CHANGE MODE column is used to:

- Allow changing of all parameters in the menu (*SETTING CHANGE MODE*, see section 1.5.1)
- Set a new password or change the existing password (Change Password, see section 1.5.3)

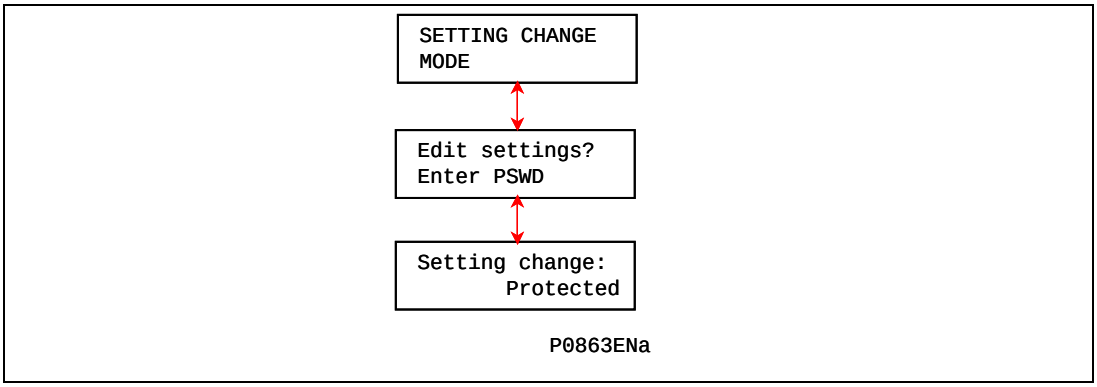


Figure 9: SETTING CHANGE MODE column

GS

1.6.8 Menu Map

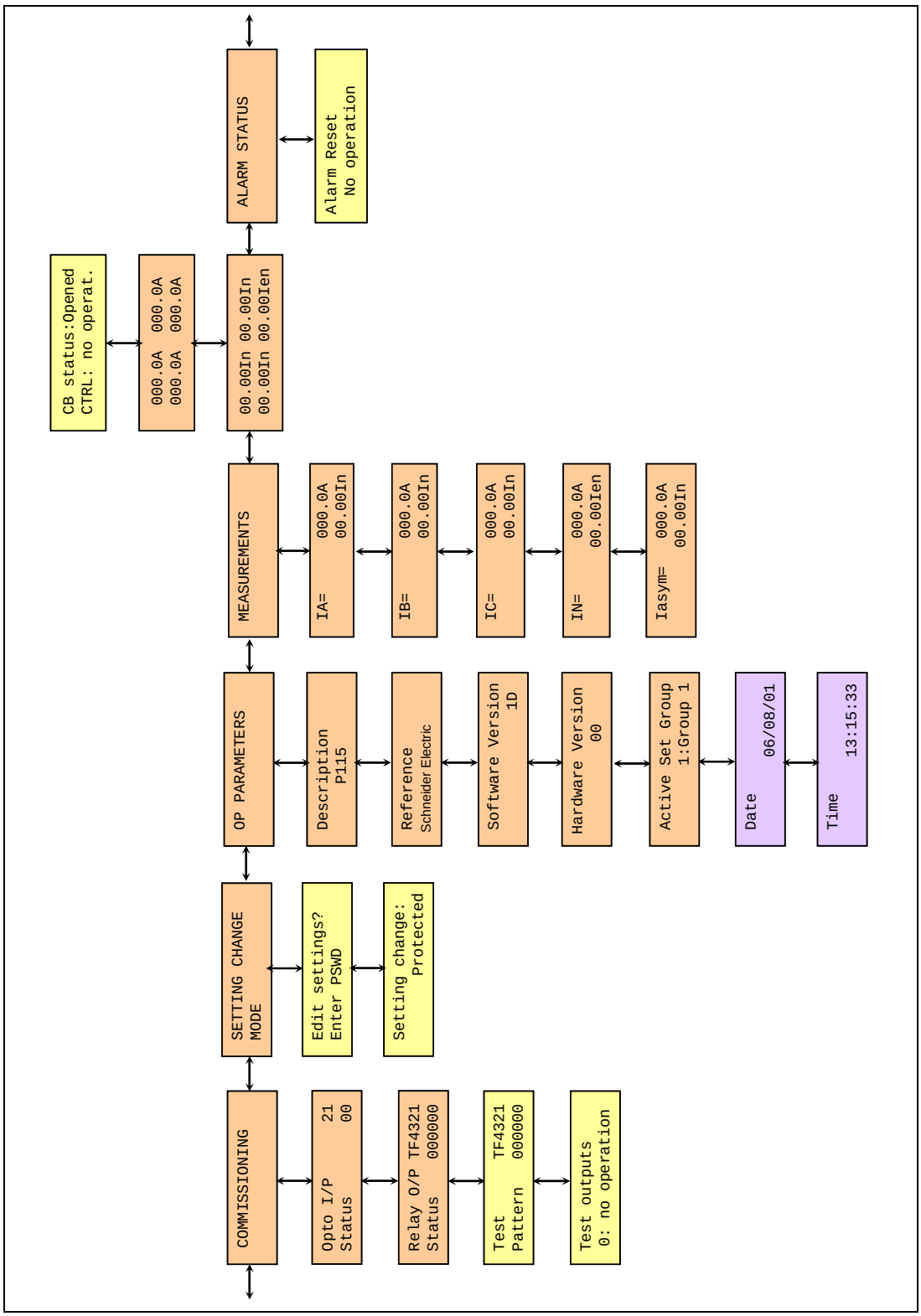


Figure 10: P115 Menu Map (Firmware: 1D) - Page 1

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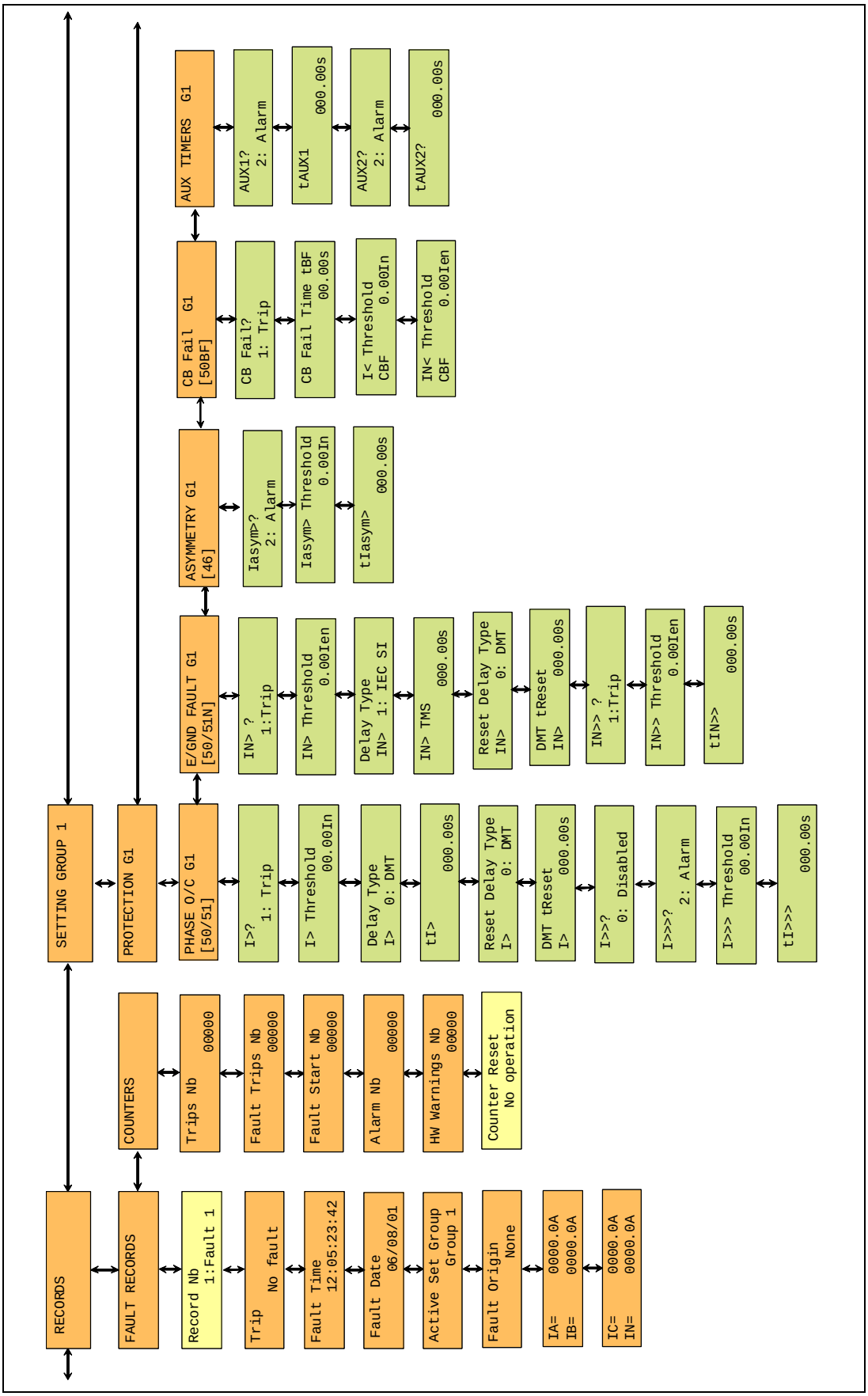

Figure 11: P115 Menu Map (Firmware: 1D) - Page 2

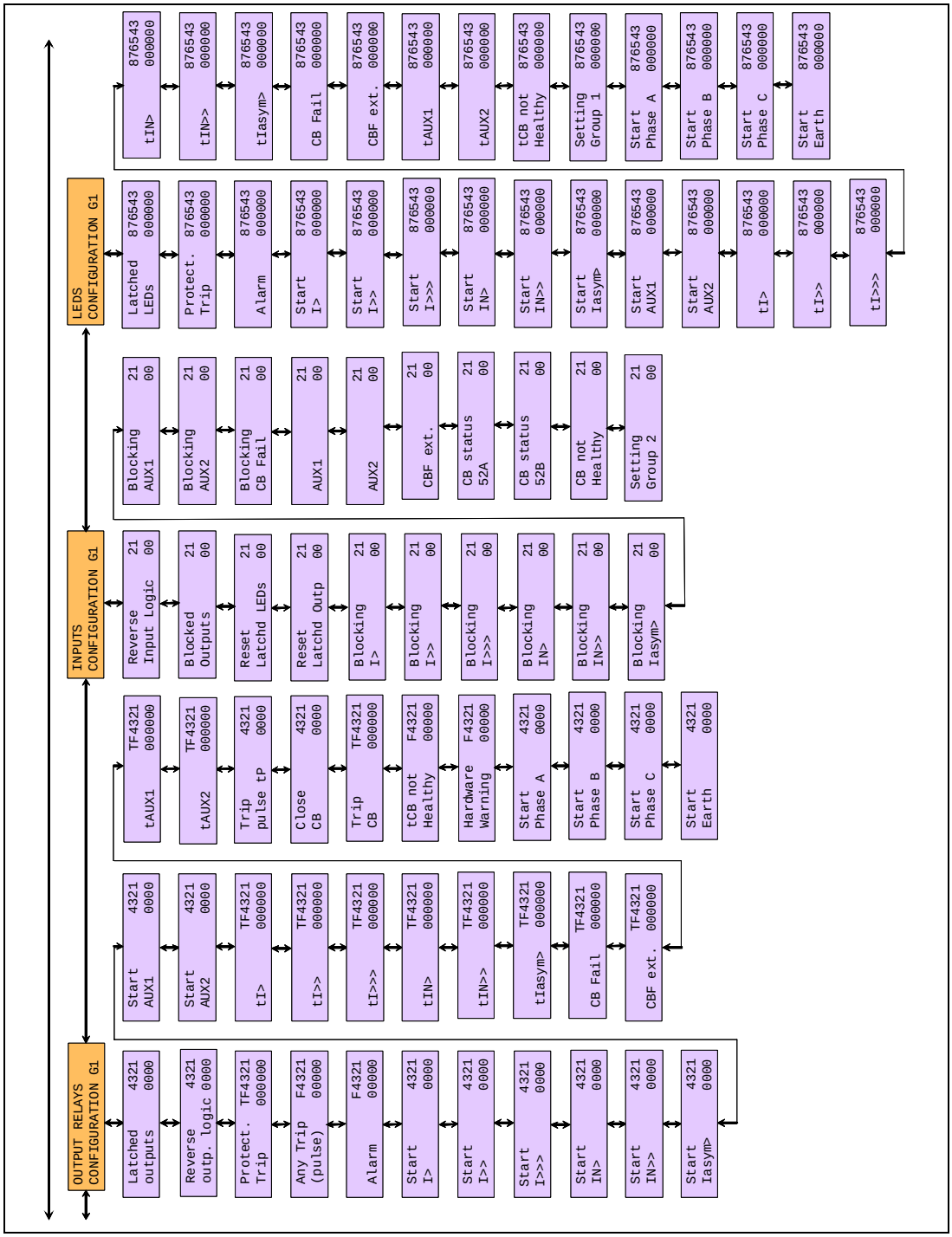
OUTPUT RELAYS CONFIGURATION G1
Latched outputs 4321 0000
Reverse outp. logic 4321 0000
Protect. Trip TF4321 000000
Any Trip (pulse) F4321 00000
Alarm F4321 00000
Start I> 4321 0000
Start I>> 4321 0000
Start I>>> 4321 0000
Start IN> 4321 0000
Start IN>> 4321 0000
Start Iasym> 4321 0000
INPUTS CONFIGURATION G1
Reverse Input Logic 21 00
Blocked Outputs 21 00
Reset Latchd LEDs 21 00
Reset Latchd Outp 21 00
Blocking I> 21 00
Blocking I>> 21 00
Blocking I>>> 21 00
Blocking IN> 21 00
Blocking IN>> 21 00
Blocking Iasym> 21 00
LEDS CONFIGURATION G1
Latched LEDs 876543 000000
Protect. Trip 876543 000000
Alarm 876543 000000
Start I> 876543 000000
Start I>> 876543 000000
Start I>>> 876543 000000
Start IN> 876543 000000
Start IN>> 876543 000000
Start Iasym> 876543 000000
Start AUX1 876543 000000
Start AUX2 876543 000000
tI> 876543 000000
tI>> 876543 000000
tI>>> 876543 000000
Start AUX1 4321 0000
Start AUX2 4321 0000
tI> TF4321 000000
tI>> TF4321 000000
tI>>> TF4321 000000
tIN> TF4321 000000
tIN>> TF4321 000000
tIasym> TF4321 000000
CB Fail TF4321 000000
CBF ext. TF4321 000000
tAUX1 TF4321 000000
tAUX2 TF4321 000000
Trip pulse tP 4321 0000
Close CB 4321 0000
Trip CB TF4321 000000
tCB not Healthy F4321 00000
Hardware Warning F4321 00000
Start Phase A 4321 0000
Start Phase B 4321 0000
Start Phase C 4321 0000
Start Earth 4321 0000
Blocking AUX1 21 00
Blocking AUX2 21 00
Blocking CB Fail 21 00
AUX1 21 00
AUX2 21 00
CBF ext. 21 00
CB status 52A 21 00
CB status 52B 21 00
CB not Healthy 21 00
Setting Group 2 21 00
tIN> 876543 000000
tIN>> 876543 000000
tIasym> 876543 000000
CB Fail 876543 000000
CBF ext. 876543 000000
tAUX1 876543 000000
tAUX2 876543 000000
tCB not Healthy 876543 000000
Setting Group 1 876543 000000
Start Phase A 876543 000000
Start Phase B 876543 000000
Start Phase C 876543 000000
Start Earth 876543 000000

Figure 12: P115 Menu Map (Firmware: 1D) - Page 3

GS

GS

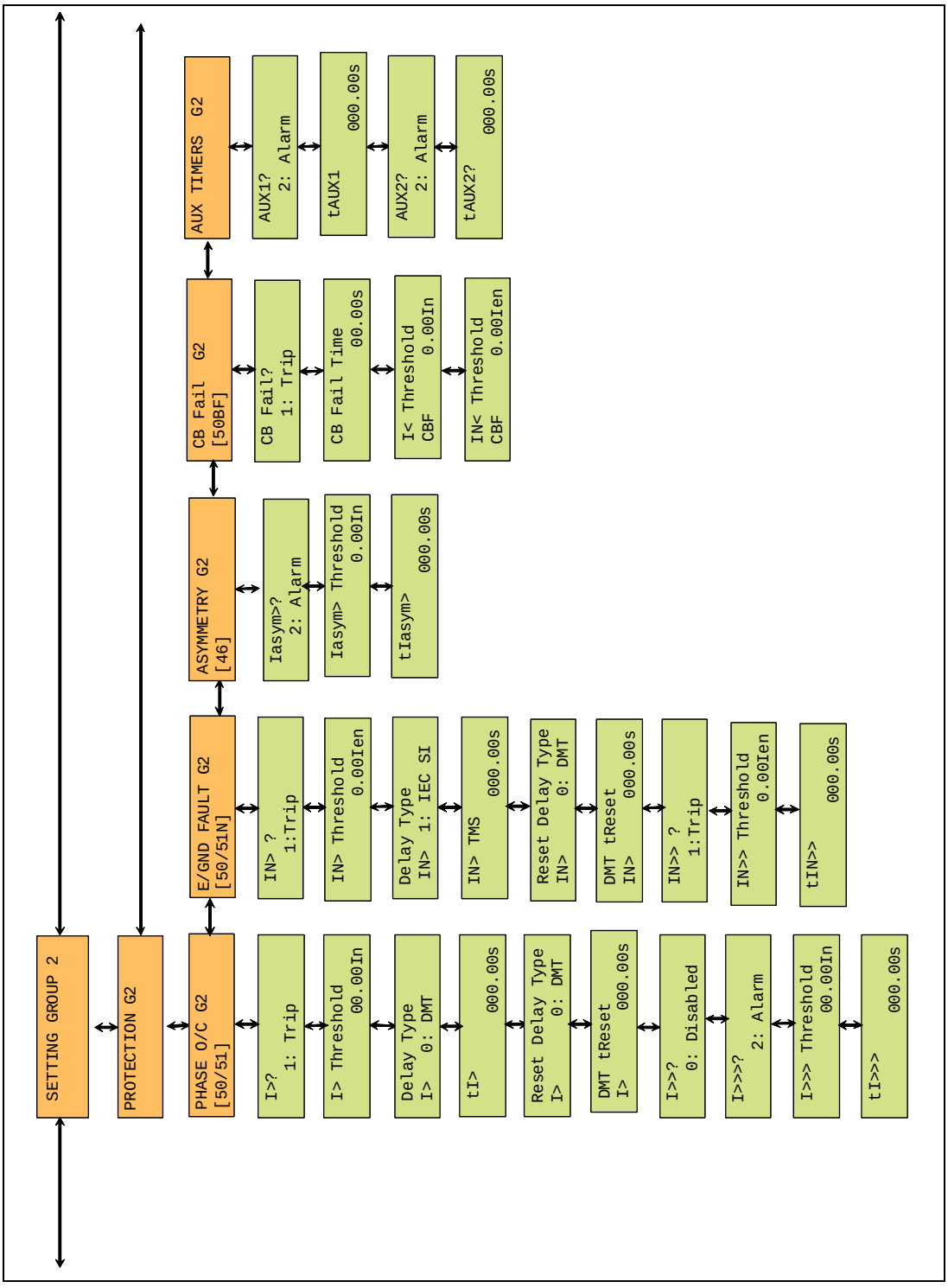

Figure 13: P115 Menu Map (Firmware: 1D) - Page 4

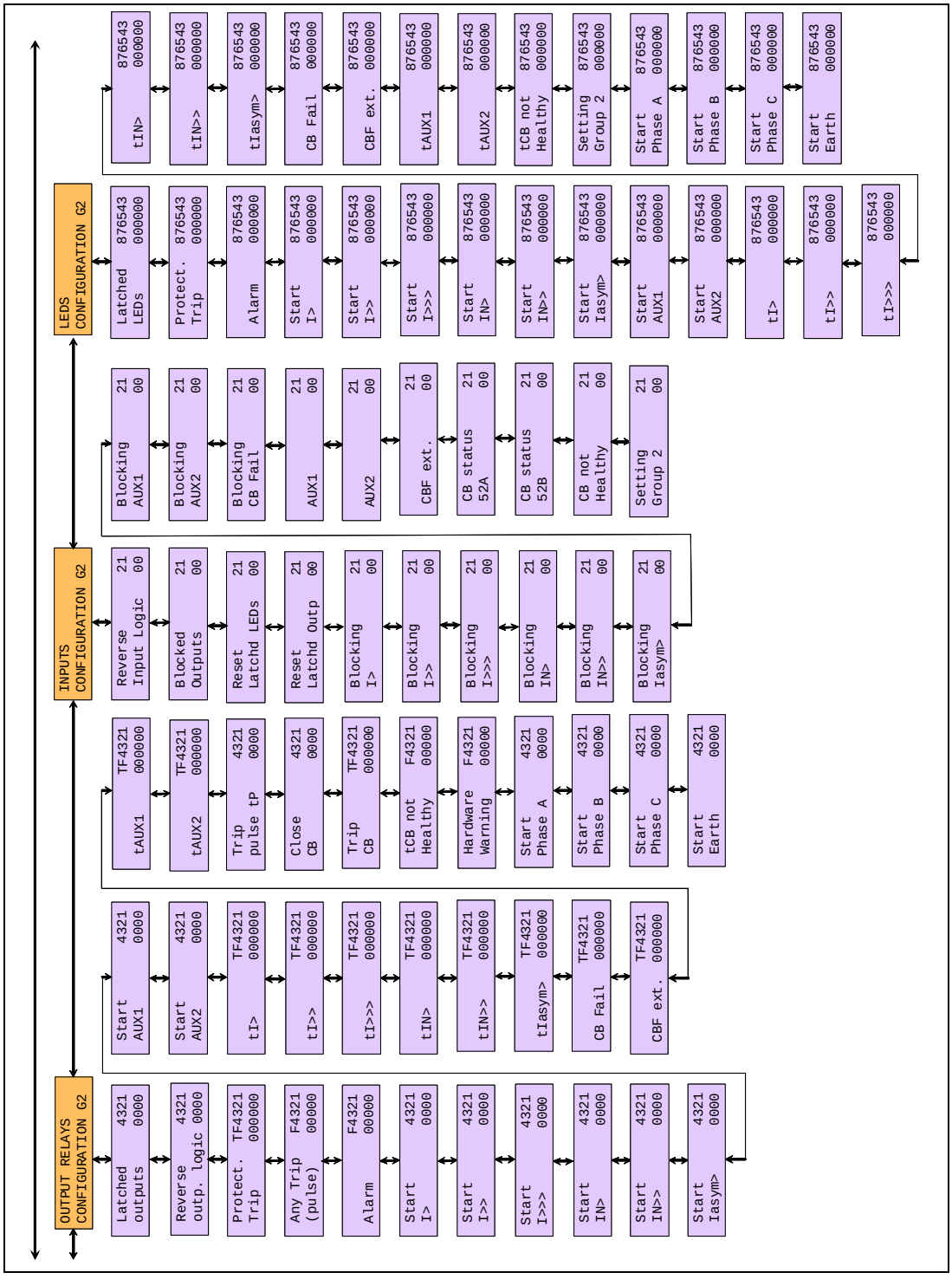

Figure 14: P115 Menu Map (Firmware: 1D) - Page 5

GS

GS

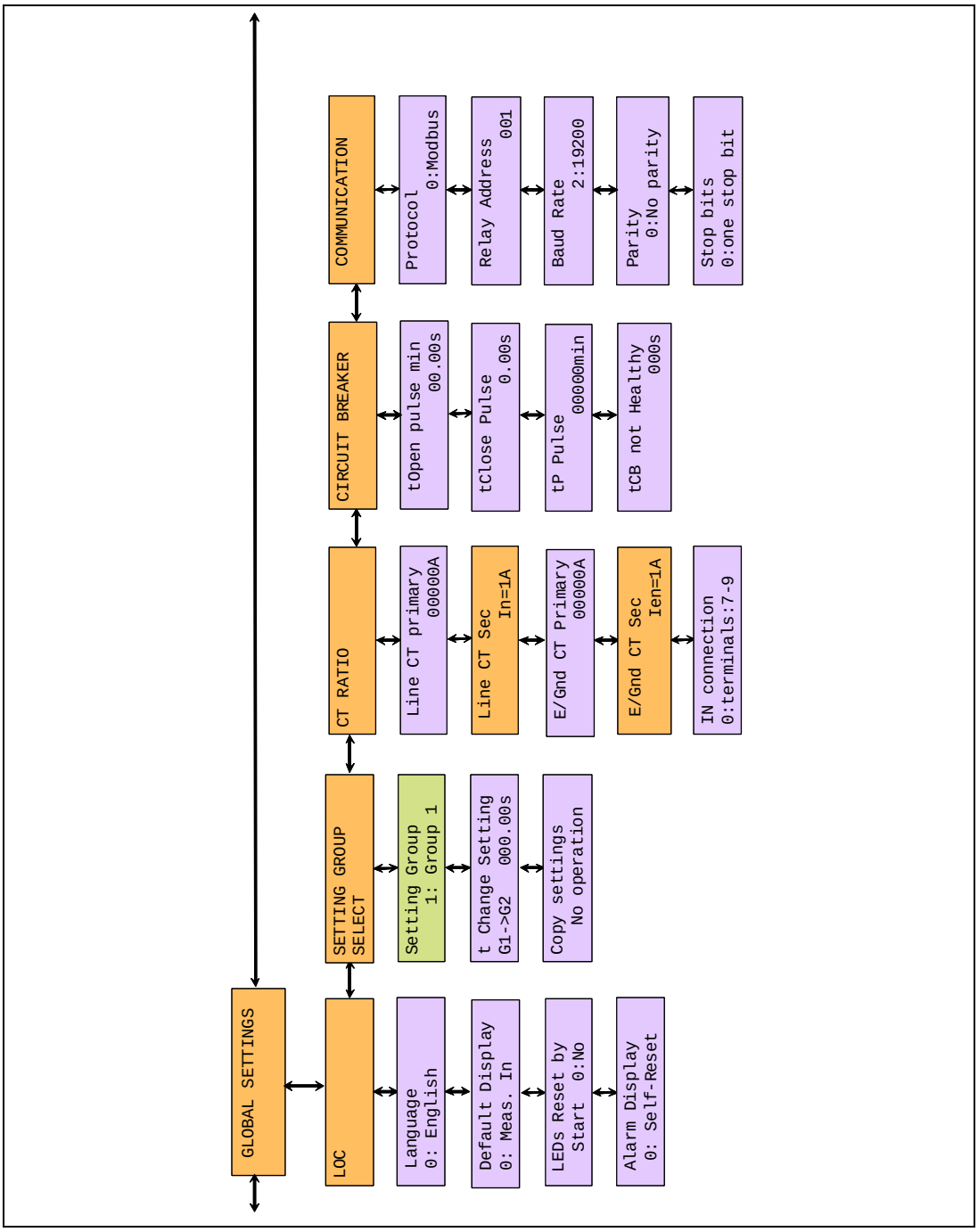

Figure 15: P115 Menu Map (Firmware: 1D) - Page 6

ST

SETTINGS

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

ST

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1. GENERAL INFORMATION

The P115 must be configured to the system and application by means of the appropriate settings. This section gives instructions for determining the settings, which are located in the folder entitled, Schneider Electric in the menu tree. The order in which the settings are listed and described in this chapter is: the protection settings, control and configuration settings (see section P115/EN GS for the detailed relay menu map). The relay is supplied with a factory-set configuration of default settings.

All current settings refer to nominal current (ordering option: 1 A or 5 A). The nominal current can be defined separately for phase (In) and earth (Ien) currents in the ordering process (ordering hardware option).

MiCOM S1 can be used to download and upload protection and configuration setting values via the relay's USB port.

The protection and I/O settings include all the following items that become active once enabled in the configuration column of the relay menu database:

– Protection element settings.

– Output settings

– Input settings

– LED settings

There are two groups of protection and I/O settings, with each group containing the same setting cells. One group of protection and I/O settings is selected as the active group, and is used by the protection elements. The settings for group 1 are shown. The settings are discussed in the same order in which they are displayed in the menu.

The menu structure is as follows:

- DEFAULT WINDOW (Currents in multiples of In, currents in Amps, CB Control window)
- ALARM STATUS
- RECORDS
    - FAULT RECORDS
    - COUNTERS
- SETTING GROUP 1
    - PROTECTION G1
        - PHASE O/C G1 [50/51]
        - E/GND FAULT G1 [50N/51N]
        - ASYMMETRY G1 [46]
        - CB FAIL G1 [50BF]
        - AUX TIMERS G1
    - OUTPUT RELAY CONFIGURATION G1
    - INPUTS CONFIGURATION G1
    - LEDS CONFIGURATION G1

- SETTING GROUP 2
    - PROTECTION G2
        - PHASE O/C G2 [50/51]
        - E/GND FAULT G2 [50N/51N]
        - ASYMMETRY G2 [46]
        - CB FAIL G2 [50BF]
        - AUX TIMERS G2
    - OUTPUT RELAY CONFIGURATION G2
    - INPUTS CONFIGURATION G2
    - LEDS CONFIGURATION G2
- GLOBAL SETTINGS
    - LOC
    - SETTING GROUP SELECT
    - CT RATIO
    - CIRCUIT BREAKER
    - COMMUNICATION
- COMMISIONING
- SETTING CHANGE MODE
- OP PARAMETERS
- MEASUREMENTS

2. SETTINGS

2.1 Protection settings

2.1.1 Phase O/C [50/51]

The overcurrent protection included in the P115 relay provides three-stage non-directional three-phase overcurrent protection with independent time delay characteristics. All overcurrent settings apply to all of the three phases but are independent for each of the three stages.

The first two overcurrent stages have time-delayed characteristics which are selectable between inverse definite minimum time (IDMT), or definite time (DMT). The third stage has definite time characteristics only.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
I> ?	Disabled	Disabled, Enable Trip, Enable Alarm		
Setting for Disable or enable of protection element. It is possible to enable for tripping CB (Enable Trip) or enable for an Alarm signal only (Enable Alarm). If the protection element is “Enable Trip” configured it means that it is set to the General Trip Command ("Protect. Trip"), which can be used in I/O configuration. If the protection element is “Enable Alarm” it means that it is set to the General Alarm Command ("Alarm"), which can be used in I/O configuration.				
I> Threshold	1.4 x In	0.2 x In	4.0 x In	0.01 x In
Pick-up setting for first stage of the overcurrent element.				
I> Delay Type	IEC SI	DMT, IEC SI, IEC VI, IEC EI, UK LTI, UK STI, UK RC, RI, IEEE MI, IEEE VI, IEEE EI, US CO2, US CO8		
Setting for the tripping characteristic for the first stage overcurrent element.				
tI>	1s	0.02s	200s	0.01s
Setting for the time-delay for the definite time setting if selected for first stage element.				
I> TMS	1	0.02	1.6	0.01
Setting for the time multiplier setting to adjust the operating time of the IEC, UK, and RI IDMT characteristic				
I> Time Dial	1	0.02	200	0.01
Setting for the time multiplier setting to adjust the operating time of the IEEE/US IDMT curves.				
Reset Delay Type I>	DMT	DMT or IDMT		N/A
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
DMT tReset I>	0s	0s	200s	0.01s
Setting that determines the reset/release time for definite time reset characteristic.				
I>> ?	Disabled	Disabled, Enable Trip, Enable Alarm		
Setting for Disable or enable of protection element. It is possible to enable for tripping CB (Enable Trip) or enable for an Alarm signal only (Enable Alarm). If the protection element is “Enable Trip” configured it means that it is set to the General Trip Command ("Protect. Trip"), which can be used in I/O configuration. If the protection element is “Enable Alarm” it means that it is set to the General Alarm Command ("Alarm"), which can be used in I/O configuration.				
I>> Threshold	1.4 x In	0.2 x In	4.0 x In	0.01 x In
Pick-up setting for second stage of the overcurrent element.				

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Delay Type I>>	IEC SI	DMT, IEC SI, IEC VI, IEC EI, UK LTI, UK STI, UK RC, RI, IEEE MI, IEEE VI, IEEE EI, US CO2, US CO8		
Setting for the tripping characteristic for this stage overcurrent element.				
tI>>	1	0.02	200	0.01
Setting for the time-delay for the definite time setting if selected for this stage element.				
I>> TMS	1	0.02	1.6	0.01
Setting for the time multiplier setting to adjust the operating time of the IEC, UK, and RI IDMT characteristic.				
I>> Time Dial	1	0.02	200	0.01
Setting for the time multiplier setting to adjust the operating time of the IEEE/US IDMT curves.				
Reset Delay Type I>>	DMT	DMT or IDMT		N/A
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
DMT tReset I>>	0s	0s	200s	0.01s
Setting that determines the reset/release time for definite time reset characteristic.				
I>>> ?	Disabled	Disabled, Enable Trip, Enable Alarm		
Setting for Disable or enable of protection element. It is possible to enable for tripping CB (Enable Trip) or enable for an Alarm signal only (Enable Alarm). If the protection element is “Enable Trip” configured it means that it is set to the General Trip Command ("Protect. Trip"), which can be used in I/O configuration. If the protection element is “Enable Alarm” it means that it is set to the General Alarm Command ("Alarm"), which can be used in I/O configuration.				
I>>> Threshold	4 x In	0.2 x In	40.0 x In	0.1 x In
Pick-up setting for third stage of the overcurrent element.				
tI>>>	0.1s	0s	200s	0.01s
Setting for the time-delay for the definite time setting if selected for this stage element.				

2.1.2 E/Gnd Fault [50N/51N]

The earth fault element operates from earth fault current that is measured directly from the system; either by means of a separate CT located in a power system earth connection or via a residual connection of the three line CT's.

All overcurrent settings are independent for each of the two stages.

The first stage of e/f non-directional overcurrent protection has time-delayed characteristics which are selectable between inverse definite minimum time (IDMT), or definite time (DMT). The second stage has definite time characteristics only.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
IN> ?	Disabled	Disabled, Enable Trip, Enable Alarm		
Setting for Disable or enable of protection element. It is possible to enable for tripping CB (Enable Trip) or enable for an Alarm signal only (Enable Alarm). If the protection element is “Enable Trip” configured it means that it is set to the General Trip Command ("Protect. Trip"), which can be used in I/O configuration. If the protection element is “Enable Alarm” it means that it is set to the General Alarm Command ("Alarm"), which can be used in I/O configuration.				
IN> Threshold	0.1 x Ien	0.01 x Ien	0.2 x Ien	0.01 x Ien
Pick-up setting for first stage e/f overcurrent element. For dynamic range (ordering option): 0.01-2Ien, where Ien: nominal current for e/f input.				
IN> Threshold	0.5 x Ien	0.05 x Ien	1.0 x Ien	0.01 x Ien
Pick-up setting for first stage overcurrent element. For dynamic range (ordering option): 0.05-10Ien, where Ien: nominal current for e/f input.				
IN> Threshold	1 x Ien	0.2 x Ien	4.0 x Ien	0.01 x Ien
Pick-up setting for first stage e/f overcurrent element. For dynamic range (ordering option): 0.2-40Ien, where Ien: nominal current for e/f input.				
Delay Type IN>	IEC SI	DMT, IEC SI, IEC VI, IEC EI, UK LTI, UK STI, UK RC, RI, IEEE MI, IEEE VI, IEEE EI, US CO2, US CO8		
Setting for the tripping characteristic for the first stage e/f overcurrent element.				
tIN>	1s	0.02s	200s	0.01s
Setting for the time-delay for the definite time setting if selected for first e/f stage element.				
IN> TMS	1	0.02	1.6	0.01
Setting for the time multiplier setting to adjust the operating time of the IEC, UK, and RI IDMT characteristic.				
IN> Time Dial	1	0.02	200	0.01
Setting for the time multiplier setting to adjust the operating time of the IEEE/US IDMT curves.				
Reset Delay Type IN>	DMT	DMT or IDMT		N/A
Setting to determine the type of reset/release characteristic of the IEEE/US curves.				
DMT tReset IN>	0s	0s	200s	0.01s
Setting that determines the reset/release time for definite time reset characteristic.				

ST

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
IN>> ?	Disabled	Disabled, Enable Trip, Enable Alarm		
Setting for Disable or enable of protection element. It is possible to enable for tripping CB (Enable Trip) or enable for an Alarm signal only (Enable Alarm). If the protection element is “Enable Trip” configured it means that it is set to the General Trip Command ("Protect. Trip"), which can be used in I/O configuration. If the protection element is “Enable Alarm” it means that it is set to the General Alarm Command ("Alarm"), which can be used in I/O configuration.				
IN>> Threshold	0.5 x Ien	0.01 x Ien	2.0 x Ien	0.01 x Ien
Pick-up setting for second stage of the e/f overcurrent element. For dynamic range (ordering option): 0.01-2Ien, where Ien: nominal current for e/f input.				
IN>> Threshold	2.5 x Ien	0.05 x Ien	10.0 x Ien	0.01 x Ien
Pick-up setting for second stage of the overcurrent element. For dynamic range (ordering option): 0.05-10Ien, where Ien: nominal current for e/f input.				
IN>> Threshold	5 x Ien	0.2 x Ien	40.0 x Ien	0.1 x Ien
Pick-up setting for second stage of the e/f overcurrent element. For dynamic range (ordering option): 0.2-40Ien, where Ien: nominal current for e/f input.				
tIN>>	0.1s	0s	200s	0.01s
Setting for the time-delay for the definite time setting if selected for this stage.				

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2.1.3 Asymmetry [46]

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Iasym> ?	Disabled	Disabled, Enable Trip, Enable Alarm		N/A
Setting for Disable or enable of asymmetry element. It is possible to enable for tripping CB (Enable Trip) or enable for an Alarm signal only (Enable Alarm). If the protection element is “Enable Trip” configured it means that it is set to the General Trip Command ("Protect. Trip"), which can be used in I/O configuration. If the protection element is “Enable Alarm” it means that it is set to the General Alarm Command ("Alarm"), which can be used in I/O configuration.				
Iasym> Threshold	0.2 x In	0.08 x In	4 x In	0.01 x In
Pick-up setting for the asymmetry overcurrent element.				
tIasym	10 s	0 s	200 s	0.01 s
Setting for the operating time-delay for the asymmetry overcurrent element.				

2.1.4 CB Fail [50BF]

This function consists of a circuit breaker fail function that can be initiated by:

- Current based protection elements
- External protection element: CBF ext..

For current-based protection, the reset condition is based on undercurrent operation to determine whether the CB has opened.

It is common practice to use low set undercurrent elements in protection relays to indicate that circuit breaker poles have interrupted the fault or load current, as required.

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
CBF ?	Disabled	Disabled, Enable Trip, Enable Alarm		
Setting to enable or disable the circuit breaker supervision function.				
CB Fail Time tBF	0.2 s	0 s	10 s	0.01 s
Setting for the circuit breaker fail timer stage for which the initiating condition must be valid.				
I< Threshold CBF	0.1 x In	0.05 x In	4 x In	0.01 x In
Setting that determines the circuit breaker fail timer reset current for overcurrent based protection circuit breaker fail initiation.				
IN< Threshold CBF	0.1 x Ien	0.01 x Ien	2 x Ien	0.01 x Ien
Setting that determines the circuit breaker fail timer reset current for earth fault current based protection circuit breaker fail initiation. For dynamic range (ordering option): 0.01-2Ien, where Ien: nominal current for e/f input				
IN< Threshold CBF	0.1 x Ien	0.05 x Ien	10 x Ien	0.01 x Ien
Setting that determines the circuit breaker fail timer reset current for earth fault current based protection circuit breaker fail initiation. For dynamic range (ordering option): 0.05-10Ien, where Ien: nominal current for e/f input				
IN< Threshold CBF	0.1 x Ien	0.05 x Ien	4 x Ien	0.01 x Ien
Setting that determines the circuit breaker fail timer reset current for earth fault current based protection circuit breaker fail initiation. For dynamic range (ordering option): 0.2-40Ien, where Ien: nominal current for e/f input.				

2.1.5 AUX Timers

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
AUX1 ?	Disabled	Disabled, Enable Trip, Enable Alarm		N/A
Setting for Disable or enable of AUX1 element. It is possible to enable for tripping CB (Enable Trip) or enable for an Alarm signal only (Enable Alarm). If the protection element is “Enable Trip” configured it means that it is set to the General Trip Command ("Protect. Trip"), which can be used in I/O configuration. If the protection element is “Enable Alarm” it means that it is set to the General Alarm Command ("Alarm"), which can be used in I/O configuration.				
tAUX1	10	0s	200s	0.01s
Setting for the operating time-delay for AUX1 function.				
AUX2 ?	Disabled	Disabled, Enable Trip, Enable Alarm		N/A
Setting for Disable or enable of AUX2 element. It is possible to enable for tripping CB (Enable Trip) or enable for an Alarm signal only (Enable Alarm). If the protection element is “Enable Trip” configured it means that it is set to the General Trip Command ("Protect. Trip"), which can be used in I/O configuration. If the protection element is “Enable Alarm” it means that it is set to the General Alarm Command ("Alarm"), which can be used in I/O configuration.				
tAUX2	10 s	0 s	200 s	0.01 s
Setting for the operating time-delay for AUX2 function.				

2.2 Configuration of the output relays

Output settings define which signal is connected with P115 outputs.
Matrix configuration allows the free configuration of functions to the outputs.

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Latched Outputs	0000	0-1,0-1,0-1,0-1	1

Every output can be configured with latching of output or without.

Default Setting: “0100” means that:

RL4: “0” – output RL4 is not latched. The high state of the function configured to the output determines the high state of RL4. The low state of this function determines the low state RL4

RL3: “0” – output RL3 is not latched. The high state of the function configured to the output determines the high state of RL3. The low state of this function determines the low state of RL3

RL2: “0” – output RL2 is not latched. The high state of the function configured to the output determines the high state of RL2. The low state of this function determines the low state RL2

RL1: “0” – output RL1 is not latched. The high state of the function configured to the output determines the high state of RL1. The low state of this function determines the low state RL1

The high state of the function configured to the output determines the high state of the output relay. The low state of this function does not change the state of the output relay. For the low state of an output relay, it is necessary to activate the *Reset of Latched Output* function (via a Binary Input, the front panel or the communication port)

Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Reverse outp.logic	0000	0-1,0-1,0-1,0-1	1

Reverse logic gives more flexibility of application. If reverse logic for the output is chosen, after the P115 is powered (current, auxiliary voltage) the output contacts close contact. Any high state function connected with this output will open the contacts of the output relay.

Default Setting: “0000” means that:

RL4: “0” – output RL4 is without reverse logic.
The state of the output is in line with the state of the function

RL3: “0” – output RL3 is without reverse logic.
The state of the output is in line with the state of the function

RL2: “0” – output RL2 is without reverse logic.
The state of the output is in line with the state of the function

RL1: “0” – output RL1 is without reverse logic.
The state of the output is the same as the state of the function

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
Protection Trip	110000	0–1,0-1, 0-1,0-1,0-1, 0-1	1

Protection trip is high if any protection element configured: "*Enable Trip*" is high (Current based protection elements and external protection elements: AUX1, AUX2, CBF re-trip).

Default Setting: "110000" means that:

TC: "1" – the Low Energy Tripping Coil output for is configured to the Protection trip function
FI: "1" – the Flag Indicator output is configured to the Protection trip function

RL4: "0" – output RL4 is not configured to the Protection trip function
RL3: "0" – output RL3 is not configured to the Protection trip function
RL2: "0" – output RL2 is not configured to the Protection trip function
RL1: "1" – output RL1 is configured to the Protection trip function

ST

Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Any Trip (pulse)	0001	0-1,0-1,0-1,0-1	1

Any Trip is high if either Protection Trip (see above), Operation Trip via the communication port or Operation Trip from the front panel is high when the tP time-delay (**tOpen** pulse duration set in *GLOBAL SETTINGS/CIRCUIT BREAKER/tOpen pulse min*) elapses.

Default Setting: "0001" means that:

RL4: "0" – output RL4 is not configured to the *Any Trip* function.

RL3: "0" – output RL3 is not configured to the *Any Trip* function.

RL2: "0" – output RL2 is not configured to the *Any Trip* function.

RL1: "1" – output RL1 is configured to the *Any Trip* function.

Note: The Low Energy Tripping Coil output and Flag Indicator output is not connected with this function.

Description of bits:	**FI,RL4,RL3,RL2,RL1**	**FI,RL4,RL3,RL2,RL1**	
Alarm	00000	0-1,0-1,0-1,0-1, 0-1	1

Alarm function is high if any protection element configured: "Enable Alarm" is high (Current based protection elements and external protection elements: AUX1, AUX2).

Default Setting: "00000" means that:

FI: "0" – output for Flag Indicator is not configured to Alarm function

RL4: "0" – output RL4 is not configured to *Alarm* function
RL3: "0" – output RL3 is not configured to *Alarm* function
RL2: "0" – output RL2 is not configured to *Alarm* function
RL1: "0" – output RL1 is not configured to *Alarm* function

Note: The Low Energy Tripping Coil output is not connected with this function.

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start I>	0000	0-1,0-1,0-1,0-1	1
Start I> function is high if I> protection element is energized (current is above set I>> threshold)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start I>>	0000	0-1,0-1,0-1,0-1	1
Start I>> function is high if I>> protection element is energized (current is above set I>> threshold)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start I>>>	0000	0-1,0-1,0-1,0-1	1
Start I>>> function is high if I>>> protection element is energized (current is above set I>>> threshold)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start IN>	0000	0-1,0-1,0-1,0-1	1
Start IN> function is high if IN> protection element is energized (e/f current is above set IN> threshold)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start IN>>	0000	0-1,0-1,0-1,0-1	1
Start IN>> function is high if IN>> protection element is energized (e/f current is above set IN>> threshold)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start Iasym>	0000	0-1,0-1,0-1,0-1	1
Start Iasym> function is high if Iasym> protection element is energized (asymmetry current is above set Iasym> threshold)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start AUX1	0000	0-1,0-1,0-1,0-1	1
Start AUX1 function is high if AUX1 protection element is high			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start AUX2	0000	0-1,0-1,0-1,0-1	1
Start AUX2 function is high if AUX2 protection element is high			

ST

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
tI>	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
tI> function is high if the set time delay of I> element has elapsed			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
tI>>	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
tI>> function is high if the set time delay of I>> element has elapsed			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
tI>>>	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
tI>>> function is high if the set time delay of I>>> element has elapsed			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
tIN>	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
tIN> function is high if the set time delay of IN> element has elapsed			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
tIN>>	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
tIN>> function is high if the set time delay of IN>> element has elapsed			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
tIasym>	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
tIasym> function is high if the set time delay of Iasym> element has elapsed			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
CB Fail	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
CB Fail function is high if the set time delay of CBF protection function is elapsed			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
CB ext.	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
CB ext function is high if the logic function CB ext. is triggered via binary input. CB ext . function trigger CB Fail function. It is used if CB Fail should be start via external protection relay.			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
tAUX1	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
tAUX1 function is high if the set time delay of AUX1 element has elapsed			

ST

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
tAUX2	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
tAUX2 function is high if the set time delay of AUX2 element has elapsed			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Trip pulse tP	0000	0-1,0-1,0-1, 0-1	1
Any Trip is high if Protection Trip is high when the tP time-delay elapses (tP: trip pulse duration set in *GLOBAL SETTINGS/CIRCUIT BREAKER/tP pulse*)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Close CB	0000	0-1,0-1,0-1, 0-1	1
The Close CB function is high by the set time if the Operation Close Command is executed (Communication port, Binary Input, front panel) (the close pulse is set in *GLOBAL SETTINGS/CIRCUIT BREAKER/ tClose Pulse*)			
Description of bits:	**TC,FI,RL4,RL3,RL2,RL1**	**TC,FI,RL4,RL3,RL2,RL1**	
Trip CB	000000	0-1,0-1,0-1,0-1,0-1, 0-1	1
The Trip CB function is high by the set time if the Operation Trip Command is executed (Communication port, front panel) (the trip pulse is configured in *GLOBAL SETTINGS/CIRCUIT BREAKER/ tOpen pulse min*)			
Description of bits:	**FI,RL4,RL3,RL2,RL1**	**FI,RL4,RL3,RL2,RL1**	
CB not Healthy	00000	0-1,0-1,0-1,0-1, 0-1	1
CB not Heathy is high if the time delay of the tCB not Healthy function has elapsed. (the tCB not Healthy pulse is configured in *GLOBAL SETTINGS/CIRCUIT BREAKER/ tCB not Healthy*)			
Description of bits:	**FI,RL4,RL3,RL2,RL1**	**FI,RL4,RL3,RL2,RL1**	
Hardware Warning	00000	0-1,0-1,0-1,0-1, 0-1	1
The Hardware Warning function is high if any problems with the P115's hardware are detected. Note: To use the watchdog function it is necessary to set the chosen relay to reverse logic and use an NC contact. The above function is useful if the P115 is dual-powered (supplied from the auxiliary voltage supply).			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start Phase A	0000	0-1,0-1,0-1, 0-1	1
The Start Phase A function is high if the phase overcurrent stage (set to trip) in phase A has started (current in phase A above the phase current thresholds)			

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start Phase B	0000	0-1,0-1,0-1, 0-1	1
The Start Phase B function is high if the phase overcurrent stage (set to trip) in phase B has started (current in phase B above the phase current thresholds)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start Phase C	0000	0-1,0-1,0-1, 0-1	1
The Start Phase C function is high if the phase overcurrent stage (set to trip) in phase C has started (current in phase C above the phase current thresholds)			
Description of bits:	**RL4,RL3,RL2,RL1**	**RL4,RL3,RL2,RL1**	
Start Earth	0000	0-1,0-1,0-1, 0-1	1
The Start Earth function is high if the earth overcurrent element (set to trip) has started (earth current above the earth current thresholds)			

2.3 Configuration of the inputs

Binary Input settings define which signal is connected with Binary Input of P115. Matrix configuration allows the free configuration of functions to the inputs.

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	L2, L1	L2, L1	
Reverse Input Logic	00	0-1,0-1	1
Reverse logic provides extra flexibility to the application. Reverse logic means that the high state of binary input causes the corresponding logic signal to be in low state. Default Setting: “00” means that: L2: “0” – input L2 is without reverse logic. The state of L2 logic input is in line with the state of L2 binary input L1: “0” – input L1 is without reverse logic. The state of L1 logic input is in line with the state of L1 binary input			
Description of bits:	L2, L1	L2, L1	
Blocked Outputs	00	0-1,0-1	1
The high state of this logic input moves functions configured to all outputs to their low state			
Description of bits:	L2, L1	L2, L1	
Reset Latchd LEDs	00	0-1,0-1	1
The high state of this logic input resets all latched LEDs			
Description of bits:	L2, L1	L2, L1	
Reset Latchd Outputs	00	0-1,0-1	1
The high state of this logic input resets all latched contact outputs			
Description of bits:	L2, L1	L2, L1	
Blocking I>	00	0-1, 0-1	1
The high state of this logic input disables the I> protection element and resets its time delay			
Description of bits:	L2, L1	L2, L1	
Blocking I>>	00	0-1, 0-1	1
The high state of this logic input disables the I>> protection element and resets its time delay			
Description of bits:	L2, L1	L2, L1	
Blocking I>>>	00	0-1, 0-1	1
The high state of this logic input disables the I>>> protection element and resets its time delay			

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	L2, L1	L2, L1	
Blocking IN>	00	0-1, 0-1	1
The high state of this logic input disables the IN> protection element and resets its time delay			
Description of bits:	L2, L1	L2, L1	
Blocking IN>>	00	0-1, 0-1	1
The high state of this logic input disables the IN>> protection element and resets its time delay			
Description of bits:	L2, L1	L2, L1	
Blocking Iasym>	00	0-1, 0-1	1
The high state of this logic input disables the Iasym> element and resets its time delay			
Description of bits:	L2, L1	L2, L1	
Blocking AUX1	00	0-1, 0-1	1
The high state of this logic input disables the AUX1 protection element with and its time delay			
Description of bits:	L2, L1	L2, L1	
Blocking AUX2	00	0-1, 0-1	1
The high state of this logic input disables the AUX2 protection element and resets its time delay			
Description of bits:	L2, L1	L2, L1	
Blocking CB Fail	00	0-1, 0-1	1
The high state of this logic input disables the CB Fail protection function and resets its time delay			
Description of bits:	L2, L1	L2, L1	
AUX1	00	0-1, 0-1	1
This logic input energizes the AUX1 function			
Description of bits:	L2, L1	L2, L1	
AUX2	00	0-1, 0-1	1
This logic input energizes the AUX2 function			
Description of bits:	L2, L1	L2, L1	
CBF ext.	00	0-1, 0-1	1
This logic input energizes the CB ext. function			

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Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	L2, L1	L2, L1	
CB Status 52A	00	0-1, 0-1	1
This logic input gives information about the closed state of the CB. Information for communication system only.			
Description of bits:	L2, L1	L2, L1	
CB Status 52B	00	0-1, 0-1	1
This logic input gives information about the open state of the CB. Information for communication system only.			
Description of bits:	L2, L1	L2, L1	
CB not Healthy	00	0-1, 0-1	1
After moving the logic input's state from low to high this function blocks a close command and initiates the “tCB not Healthy” time delay. If this time has elapsed the Alarm signal is high.			
Description of bits:	L2, L1	L2, L1	
Setting group 2	00	0-1, 0-1	1
The high state of this logic input switches the active setting group to Setting Group 2. Setting Group 1 is active from the low state of Logic Input.			

2.4 Configuration of the LEDs

LED configuration settings define which signal is connected with P115 LEDs. Matrix configuration allows the free configuration of functions to the LEDs.

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Latched LEDs	111111	0–1,0-1, 0-1,0-1,0-1, 0-1	1
Every LED can be configured with latching or without. Default Setting: “1111” means that: LED8: “1” – LED 8 is latched up to LEDs reset (Binary Input, Front panel, communication system) LED7: “1” – LED 7 is latched up to LEDs reset (Binary Input, Front panel, communication system) LED6: “1” – LED 6 is latched up to LEDs reset (Binary Input, Front panel, communication system) LED5: “1” – LED 5 is latched up to LEDs reset (Binary Input, Front panel, communication system) LED4: “1” – LED 4 is latched up to LEDs reset (Binary Input, Front panel, communication system) LED3: “1” – LED 3 is latched up to LEDs reset (Binary Input, Front panel, communication system)			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Protect. Trip	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if any protection element is configured: “Trip” is high (current-based protection elements and external protection elements: AUX1, AUX2, CBF re-trip). Default Setting: “000000” means that: LED8: “0” – LED 8 is not configured to Protection trip function LED7: “0” – LED 7 is not configured to Protection trip function LED6: “0” – LED 6 is not configured to Protection trip function LED5: “0” – LED 5 is not configured to Protection trip function LED4: “0” – LED 4 is not configured to Protection trip function LED3: “0” – LED 3 is not configured to Protection trip function			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Alarm	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if any protection element set to “Alarm” is high (Current based protection elements and external protection elements: AUX1, AUX2, or CB not Healthy function).			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start I>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the phase the current exceed I> stage			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	

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Menu Text	Default Setting	Setting Range	Step Size
Start I>>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the phase current exceeds the I>> stage			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start I>>>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the phase current exceeds the I>>> stage			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start IN>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the ground current exceeds the IN> stage			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start IN>>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the ground current exceeds the IN>> stage			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start Iasym>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the unbalance current exceeds the Iasym> stage			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start AUX1	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the AUX1 timer is energized			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start AUX2	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the AUX1 timer is energized			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tI>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay for the I> element has elapsed			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tI>>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay for the I>> element has elapsed			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tI>>>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay for the I>>> element has elapsed			

ST

ST

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tIN>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay for the IN> element has elapsed			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tIN>>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay for the IN>> element has elapsed			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tIasym>	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay for the Iasym> element has elapsed			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
CB Fail	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay of the CBF protection function has elapsed			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
CBF ext.	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the CBF ext. function is enabled by the appropriate binary input			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tAUX1	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay for the AUX1 element has elapsed			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tAUX2	000000	0–1,0-1, 0-1,0-1,0-1, 0-1	1
This LED is lit if the set time delay for the AUX2 element has elapsed			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
tCB not Healthy	0000	0-1,0-1,0-1, 0-1	1
This LED is lit if the time delay for the CB not Healthy function has elapsed .			
Setting Group 1	0000	0-1,0-1,0-1, 0-1	1
This LED is lit if P115 works on the first setting group .			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start Phase A	000000	0-1,0-1,0-1,0-1,0-1,0-1	1
The Start Phase A LED is illuminated if the phase overcurrent stage (set to trip) in phase A has started (current in phase A above the phase current thresholds)			

Menu Text	Default Setting	Setting Range	Step Size
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start Phase B	000000	0-1,0-1,0-1,0-1,0-1,0-1	1
The Start Phase B LED is illuminated if the phase overcurrent stage (set to trip) in phase B has started (current in phase B above the phase current thresholds)			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start Phase C	000000	0-1,0-1,0-1,0-1,0-1,0-1	1
The Start Phase C LED is illuminated if the phase overcurrent stage (set to trip) in phase C has started (current in phase C above the phase current thresholds)			
Description of bits:	LED: 8,7,6,5,4,3	LED: 8,7,6,5,4,3	
Start Earth	000000	0-1,0-1,0-1,0-1,0-1,0-1	1
The Start Earth LED is illuminated if the earth overcurrent protection (set to trip) has started (earth current above the earth current thresholds)			

3. GLOBAL SETTINGS

3.1 LOC

Menu Text	Default Setting	Available Settings
Language	0: ENGLISH	0:ENGLSH/ 1:GERMAN/ 2: POLISH/ 3:FRENCH/ 4:SPANISH/ 5:REGIONAL
This cell is used to change the language of the menu. The REGIONAL language is used if it is necessary to change labels in the P115's menus. For example: the *CB Fail* label instead of the *AUX1* label . To change labels in the P115's menu, the *Menu Creator Software* is used. All available P115 language versions can be used as a template for the Regional menu.		
Default Display	0:Meas. In	0:Meas. In/ 1: Meas.A 2: Control
This cell is used to change the default display window 0: Measurements referred to In 1: Measurements referred to Amps 2: CB control window for control of CB (close and trip command)		
LEDs Reset by Start	0:No	0:No 1:Yes
This cell is used to change the resetting mode of latched LEDs. 0:No - Reset of latched LEDs via manual reset only (*C* clear key, input, USB, RS485) 1:Yes - Reset of latched LEDs via any protection start (set for CB tripping) or manual reset		
Alarm Display	0: Self-Reset	0: Self-Reset 1:Manual Reset
This cell is used to change the resetting mode of the Alarm indication cell (ALARM STATUS/) 0: Self-Reset - This option means that if an alarm signal has disappeared no information is available in the *ALARM STATUS* column 1:Manual Reset – this option means that if an alarm signal has disappeared information is still available in the *ALARM STATUS* column until it is reset in the *ALARM STATUS/ Alarm Reset* cell.		

ST

3.2 SETTING GROUP SELECT

Menu Text	Default Setting	Available Settings
Setting Group	1: Group 1	1:Group 1/ 2:Group2
This cell is used to change the current setting group		
t Change Settings G1→G2	0.00s	0.00 to 200s, step 0.01s
This cell is used to set the time delay changing between the setting Group 1 and Group 2		
Copy Settings	No Operation	No Operation/ Copy G1-->G2/ Copy G2→G1
When: - the 'G1→G2 command in this cell is issued, G1 will be copied to the G2 group - the 'G2→G1 command in this cell is issued, G2 will be copied to the G1 group		

3.3 CT RATIO

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Line CT Primary	1.000 A	1	30k	1
In=1A: Sets the phase current transformer input's primary current rating.				
Line CT Primary	5.000 A	5	30k	1
In=5A: Sets the phase current transformer input's primary current rating.				
Line CT Sec	1.000 A	N/A	N/A	N/A
In=1A: Sets the phase current transformer input's secondary current rating.				
Line CT Sec	5.000 A	N/A	N/A	N/A
In=5A: Sets the phase current transformer input's secondary current rating.				
E/Gnd CT Primary	1.000 A	1	30k	1
Ien=1A: Sets the earth fault current transformer input's primary current rating.				
E/Gnd CT Primary	5.000 A	5	30k	1
Ien=5A: Sets the earth fault current transformer input's primary current rating.				
E/Gnd CT Sec	1.000 A	N/A	N/A	N/A
Ien=1A: Sets the earth fault current transformer input's secondary current rating.				
E/Gnd CT Sec	5.000A	N/A	N/A	N/A
Ien=5A: Sets the earth fault current transformer input's secondary current rating.				
IN connection	0:terminals:7-9	0:terminals:7-9 1:terminals 8-9		

This cell is used to inform the P115 about the IN connection: with or without powering of the P115.

The above information is used by the P115 to reduce its energy consumption for low currents if the auxiliary supply is not connected to the 11-12 terminals.

Reducing its energy consumption allows the P115 to lower its burden on the primary MV CT.

The minimum current required to power the P115 via the CT is 0.2In, but if the CT's energy is low, the P115 switches off its LCD display, LEDs and RS485 communications when a fixed energy threshold is reached. The remaining functionalities of the P115 remain active (inputs, event recorder, fault recorder, counters, latching of LEDs and output contacts, etc).

The value used by this low energy threshold is calculated as a sum of the currents which supply the P115.

If the sum of the currents exceeds 0.5In (for example the sum: 0.5In= Ia:0.25In + Ib:0.25In+ Ic:0In + IN:0Ien) the LCD display, LEDs and RS485 are switched back on.

Depending on the *IN connection* setting: the earth current is included in the above sum (*0:terminals:7-9*) or not (*1:terminals 8-9*)
In a typical application, every type of fault with current values greater than 0.25In, gives a sum greater than 0.5In (phase to phase or phase to earth fault).

Note: if the energy level is below 0.5In, RL2, RL3, RL4 are not energized either, but if they are set as latching, when the P115 is powered again the latched RL2, RL3 and RL4 relays will remain energized until they are reset. The same applies to latched LEDs.

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3.4 CIRCUIT BREAKER

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
tOpen Pulse min	0.5 s	0.01 s	10 s	0.01 s
Defines the duration of the trip pulse				
tClose Pulse min	0.5 s	0.01 s	5 s	0.01 s
Defines the duration of the close pulse				
tP pulse	5760 mn (4 days)	1 mn	65000 mn	1 mn
Defines the duration of the trip pulse. This pulse can be used for longer signaling of trips. Note: E.g RL4 configured to this function can be used to switch on an auxiliary voltage supply after tripping, for a fixed period (for example four days). Thus ensuring communication and signaling facilities. After the fixed period Auxiliary Voltage can be disconnected from the P115's terminals automatically to save a substation battery.				
CB not Healthy	16 s	1 s	200 s	1 s
A settable time delay is included for manual closure with this circuit breaker check. If the circuit breaker does not indicate a healthy condition in this time period following a close command, then the relay will lockout and set off an alarm.				

3.5 COMMUNICATION

Menu Text	Default Setting	Setting Range		Step Size
		Min.	Max.	
Protocol	0:Modbus	0:Modbus 1:IEC103		
This cell sets the protocol used by the RS485 communications: 0: Modbus RTU protocol 1:IEC103 protocol				
Relay Address	1	1	127	1
This cell sets the unique address for the relay so that only one relay is accessed by the master station's software.				
Baud Rate	19200 bits/s	4800 bits/s , 9600 bits/s, 19200 bits/s, 38400 bits/s, 5760 bits/s, 115200 bits/s		
This cell controls the communication speed between relay and master station. It is important that both the relay and the master station have the same speed setting.				
Parity	No parity	No parity, Odd parity, Even parity		
This cell controls the parity format used in the data frames. It is important that both the relay and the master station have the same parity setting.				
Stop bits	One stop bit	One stop bit, Two stop bits		
This cell controls the stop bit format used in the data frames. It is important that both the relay and the master station have the same stop bits setting.				

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NOTE: The above parameters are applicable to the RS485 port only.

The USB port's parameters are fixed:

(i) Protocol: Modbus RTU
(ii) Address: 1
(iii) Baud Rate: 115.2 kbits/s
(iv) Comms. Mode:
Data Bit: 8
Stop bit: 1
Parity: none

4. COMMISIONING

This column contains menu cells which allow the status of the opto-isolated inputs, output relay contacts to be monitored. Additionally there are cells to test the operation of the output contacts, user-programmable LEDs.

Menu Text	Default Setting	Available Settings
Description of bits:	L2, L1	
Opto I/P Status	00	
This menu cell displays the status of the relay's opto-isolated inputs as a binary string, a '1' indicating an energized opto-isolated input and a '0' a de-energized one		
Description of bits:	RL4,RL3,RL2,RL1	
Relay O/P Status	0000	
This menu cell displays the status of the digital signals that result in energization of the output relays as a binary string, a '1' indicating an operated state and '0' a non-operated state.		
Description of bits:	TC,FI,RL4,RL3,RL2,RL1	
Test Pattern	000000	
This menu cell is used to set outputs for testing. A ' 1 ' in this cell means that the corresponding output will be energized when the test command is issued. When the test is applied (*COMMISSIONING/Test outputs* cell) the outputs set to ' 1 ' in this cell will be energized and will remain so for the duration of the *tOpen* time (*GLOBAL SETTINGS/CIRCUIT BREAKER/tOpen pulse min*).		
Description of bits:	RL4,RL3,RL2,RL1	
Test outputs	0: no operation	0: no operation 1: Apply test
This menu cell is used to apply a test to the outputs set in the *Test Pattern* cell. To apply the output test: Press enter, change a setting option from 0 to 1 (1: Apply test) and confirm this action by pressing the ENTER key. The outputs (set in the *Test Pattern* cell) are then energized and will remain so for the duration of the *tOpen* time (*GLOBAL SETTINGS/CIRCUIT BREAKER/tOpen pulse min*). Note: if the *Test control* password is not equal to 0 before an option is changed (from 0 to 1), the *Test control* password should be entered (as for every other P115 setting).		

ST

5. SETTING CHANGE MODE

This column contains menu cells which allow the settings and configuration to be changed.

Before any change of settings it is necessary to set a P115's Edit Setting Mode to “Without limits” or “Protection only”. If Changing parameters is allowed, the LEDs light one by one until the “Setting Change status” cell is in the “Protected” state.

In the “Without limits” state, it is possible to change all settings.

In the “Protection only” state, it is only possible to change protection settings (“PROTECTION” columns)

In the “Control” state, it is possible to control the CB in the default window and reset the counters in the Counter column. If the password is set to 0, no password is necessary to control the CB.

In the “Protected” state, settings are password-protected.

Menu Text	Default Setting	Available Settings
Edit Settings?	Enter PSWD	00000 - 99999
This cell is used to switch the P115 to Edit Settings in order to allow changing the settings.		
Setting Change	Protected	Protected/Without limits/Protection only/Test Control
This cell displays the level of rights to change settings.		
Change Password		00000 - 99999
This cell is displayed if the password is entered. To change the password it is necessary to press the “Enter” key and enter the new password. After that it is necessary to press enter to save the new password.		

To access the Edit Setting Menu window faster, press the left and up keys at the same time.

This action makes the menu jump to the Edit Setting Window.

Then press the Enter key, a password will be requested.

Enter the password (the default factory password is “00000”)

All the LEDs will then light up, in rapid sequence. This indicates that the P115 is operating in Edit Mode: the parameters can be changed in this state.

After having set all the required parameters, press simultaneously the Left and Up keys, then press the Enter key once.

6. OP PARAMETERS

This column contains menu cells to show some of the P115's parameters

Menu Text	Default Setting	Available Settings
Description	P115	Read only
This cell is used to show the type of relay.		
Software Version	1.D	Read only
This cell is used to show the software version (firmware)		
Hardware Version	11	Read only
This cell is used to show the hardware version ordered		
Active setting group	Group 1	Read only
This cell is used to show the active setting group		
Date	01/01/08	00/00/00 – 99/99/99
This cell is used to set the date of the internal clock		
Time	00:00:00	00:00:00 – 23/59/59
This cell is used to set the time of the internal clock NOTES: 1. A back-up clock capacitor is charged from an auxiliary voltage supply (terminals 11-12) only. The capacitor's energy allows storage of real time information for up to 2 days. When the back-up capacitor is completely discharged, it takes less than 10 minutes to recharge it completely 2. If the clock has no real time information (the back-up capacitor is recharged) and the current exceeds the minimum current required for operation, the real time is set to 01/01/2008 00:00:00. Therefore events are dated with reference to this start time value.		

ST

OP

OPERATION

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

OP

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OP

1. HARDWARE OPERATION

The P115 is supplied from power system CTs or/and from auxiliary voltage supply (terminals: 11-12). In case of loss of auxiliary voltage on the 11-12 terminals, the operation of the P115 requires a minimum current flowing in one of the three phases or earth fault input (7-9 terminals). The minimum current required for operation is 20% of the nominal current of the relay (Technical Data Section P115/EN TD).

The energy taken from the current and/or from auxiliary voltage supply is used to charge up the integrated capacitors: trip outputs and relay outputs (flag indicator). If any protection function trips, the energy is provided to the 29-30 (CB coil output) and 27-28 (flag indicator output) terminals. The output signal is a pulse, the repetition of which is dependent on the trip coil's impedance and on the current level.

If the current in one of the three phases or at earth fault input (7-9 terminals) is above 0.2 In (Ien), the following functions:

- output contact: RL1,
- all inputs (L1, L2),
- event recording,
- fault record recording,
- memorizing of latched LEDs and outputs information,
- memorizing of counter information,

are operational, even if there is no auxiliary voltage on 11-12 terminals.

If the sum of the currents which supply P115 is below 0.5In (for example the sum: 0.5In= Ia:0.25In + Ib:0.25In+ Ic:0.00In + IN:0.00Ien) when a loss of auxiliary voltage supply occurs, the following functions are no longer available:

- the RS485 communication port is switched off (no communication with the control system via the RS485 link),
- the LCD display is switched off,
- the LEDs are switched off. If after a switch-on-to-fault operation, the P115 is supplied again (currents above 0.5 In or auxiliary power or USB), the stored LED information will be displayed until it is reset,
- RL2, RL3, RL4 are not energized. If after a switch-on-to-fault operation, the P115 is supplied again (currents above 0.5 In or auxiliary power or USB), the stord output relay information will be energized until it is reset.

Depending on the *IN connection* setting: the earth current is a part of the above sum (*0:terminals:7-9*) or not (*1:terminals 8-9*)
In a typical application, every type of a fault with current values greater than 0.25In gives a sum greater than 0.5In (phase to phase or phase to earth fault).

NOTE:

1. A back-up clock capacitor is charged from an auxiliary voltage supply (terminals 11-12) only. The capacitor's energy allows storage of real time information for up to 2 days. When the back-up capacitor is completely discharged, it takes less than 10 minutes to recharge it completely.

2. If the clock has no real time information (the back-up capacitor is recharged) and the current exceeds the minimum current required for operation, the real time is set to 01/01/2008 00:00:00. Therefore events are dated with reference to this start time value.

3. If RS485 communications are required, it is recommended to supply P115 from the auxiliary voltage in order to ensure that real time information is used in the event and fault recorders.

4. The FRAM memory (settings, events, fault records, latched LEDs and outputs information) is a non-volatile memory.

5. The USB port integrates electronic boards only to allow communications with the P115 via the user interface (HMI) or the setting software. Therefore the status of inputs and outputs is not read via the P115 system. The status information available on the menu is set to its default value. Healthy information available on the Healthy LED refers to the electronic part supplied via the USB port.

6. In case of any hardware problems the “Healthy LED” is blinking. If the “Healthy LED” is not lit, this means that no source of supply is available or that P115 is not healthy. For CT powered relays it is not possible to differentiate between the above conditions. Output contacts can also be configured to the “Healthy” function (Setting Section P115/EN ST).

2. OPERATION OF INDIVIDUAL PROTECTION FUNCTIONS

The following sections detail the individual protection functions.

2.1 Overcurrent protection

The overcurrent protection included in the P115 relays provides three-stage non-directional three-phase overcurrent protection with independent time delay characteristics. All overcurrent settings apply to all three phases but are independent for each of the three stages.

The first (I>) and second (I>>) stage of overcurrent protection has time-delayed characteristics which are selectable between inverse definite minimum time (IDMT), or definite time (DMT). The third (I>>>) stage has a definite time characteristic only.

Various methods are available to achieve correct relay co-ordination on a system; by means of time alone, current alone or a combination of both time and current. Grading by means of current is only possible where there is an appreciable difference in fault level between the two relay locations. Grading by time is used by some utilities but can often lead to excessive fault clearance times at or near source substations where the fault level is highest. For these reasons the most commonly applied characteristic in coordinating overcurrent relays is the IDMT type.

The inverse time delayed characteristics indicated above comply with the following formulae:

IEC curves: $t = TMS \cdot \frac{\beta}{M^{\alpha} - 1}$;

IEEE/ANSI curves: $t = TD \cdot \left(\frac{\beta}{M^{\alpha} - 1} + L\right)$;

where:

t = Operating time in [s]

β = Constant

$M = \frac{I}{Is}$

I = Measured current in [A]

Is = Current threshold setting [A]

TMS = Time multiplier setting for IEC curves [s]

TD = Time dial setting for IEEE/US curves [s]

α = Constant

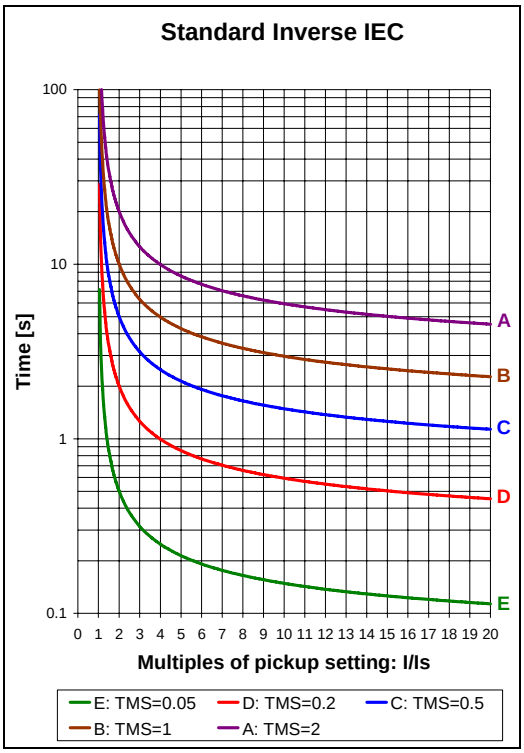
L = ANSI/IEEE Constant

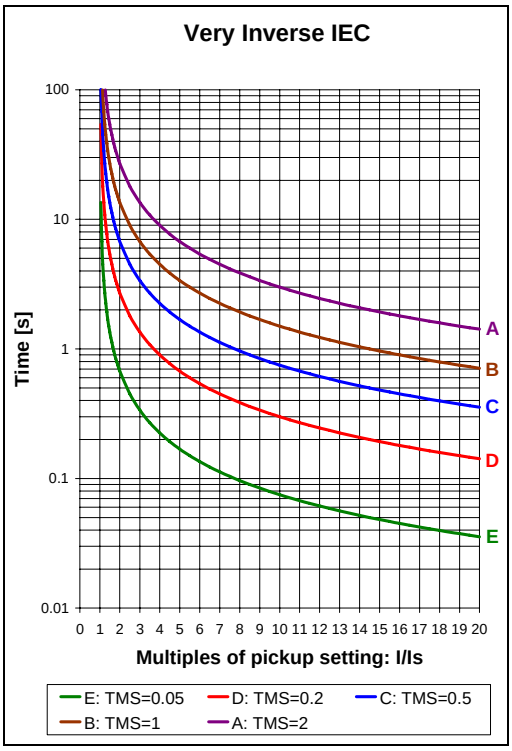
Type of Curve	Standard	β	α	L
Standard Inverse Time (SI)	IEC	0.14	0.02	0
Very Inverse Time (VI)	IEC	13.5	1	0
Extremely Inverse Time (EI)	IEC	80	2	0
Long Time Inverse (LTI)	UK	120	1	0
Short Time Inverse (STI)	UK	0.05	0.04	0
Rectifier (Rect)	UK	45900	5.6	0
Moderately Inverse Time (MI)	IEEE	0.0515	0.02	0.114
Very Inverse Time (VI)	IEEE	19.61	2	0.491
Extremely Inverse Time (EI)	IEEE	28.2	2	0.1217
Time Inverse (CO8)	US	5.95	2	0.18
Short Time Inverse (CO2)	US	0.16758	0.02	0.11858

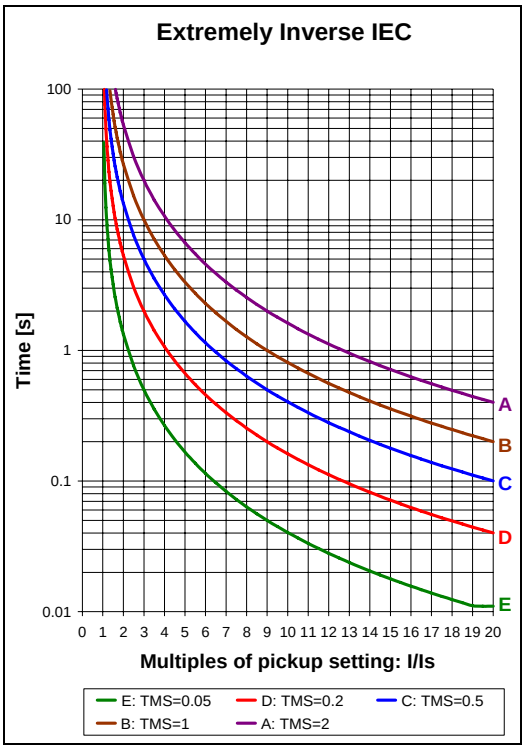
A time multiplier setting TMS is used to adjust the operating time of IEC & UK IDMT curves.

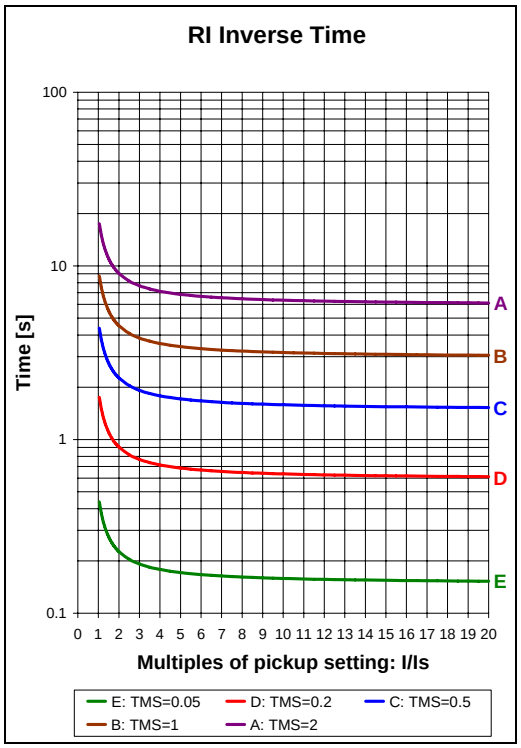
A time multiplier setting TD is used to adjust the operating time of IEEE/ANSI or US IDMT curves.

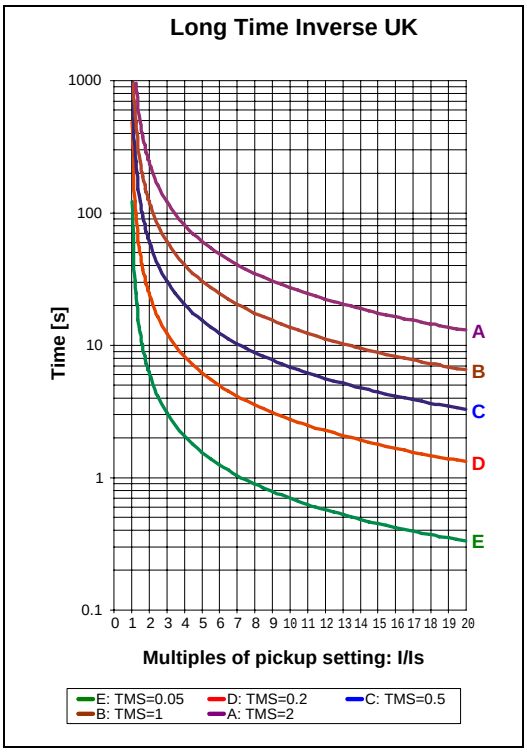
OP

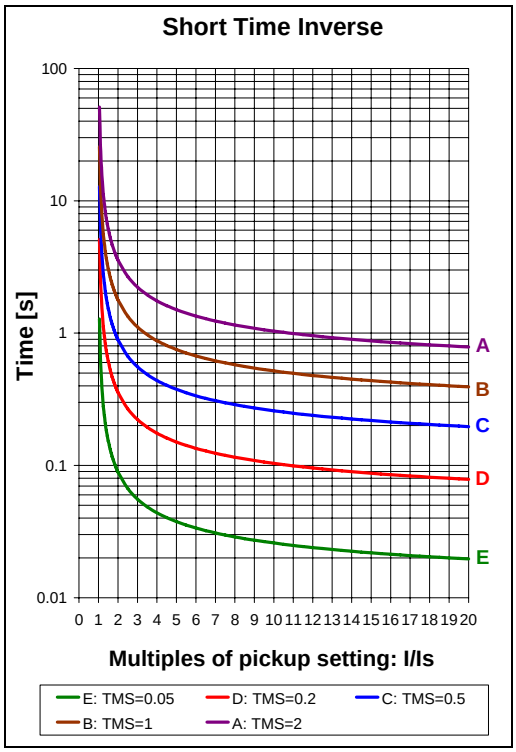





Extremely Inverse IEC
Time [s]
100
10
1
0.1
0.01
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Multiples of pickup setting: I/Is
A
B
C
D
E
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2

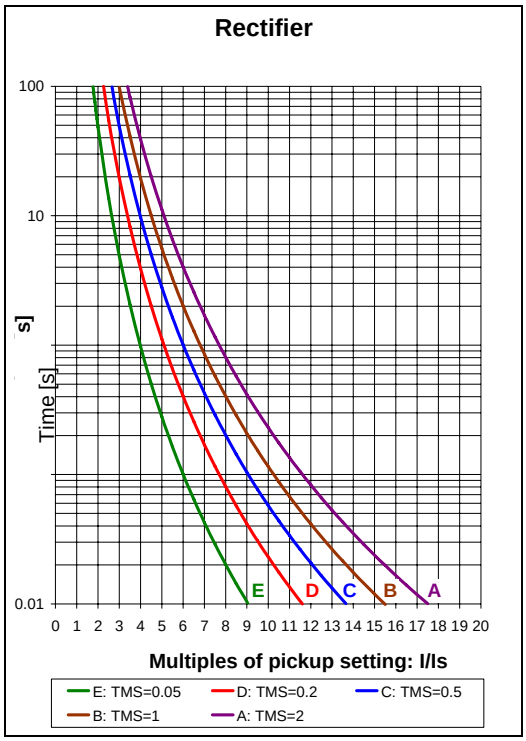

RI Inverse Time
Time [s]
100
10
1
0.1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Multiples of pickup setting: I/Is
A
B
C
D
E
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2


Long Time Inverse UK
Time [s]
1000
100
10
1
0.1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Multiples of pickup setting: I/Is
A
B
C
D
E
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2


Short Time Inverse
Time [s]
100
10
1
0.1
0.01
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Multiples of pickup setting: I/Is
A
B
C
D
E
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2

OP

OP


Rectifier
100
10
1
0.01
Time [s]
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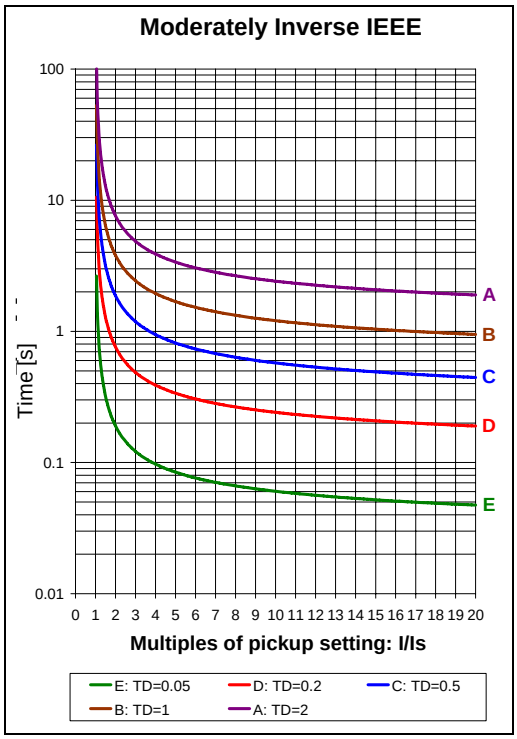
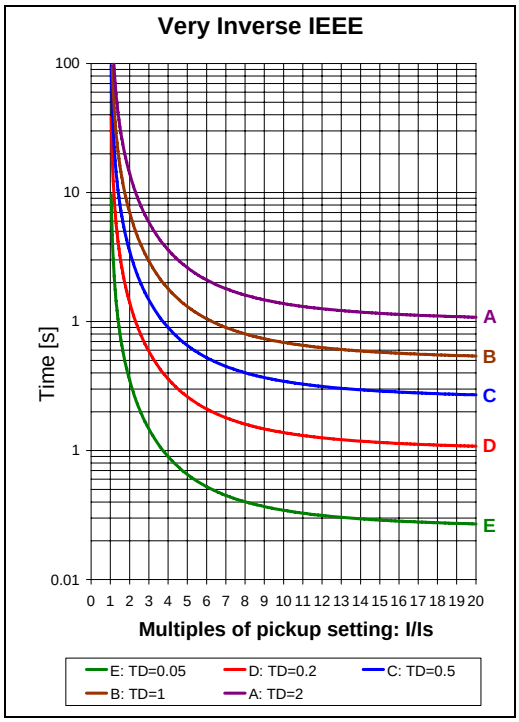
E
D
C
B
A
Multiples of pickup setting: I/Is
E: TMS=0.05
D: TMS=0.2
C: TMS=0.5
B: TMS=1
A: TMS=2


Moderately Inverse IEEE
100
10
1
0.1
0.01
Time [s]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
A
B
C
D
E
Multiples of pickup setting: I/Is
E: TD=0.05
D: TD=0.2
C: TD=0.5
B: TD=1
A: TD=2


Very Inverse IEEE
100
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1
1
0.01
Time [s]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
A
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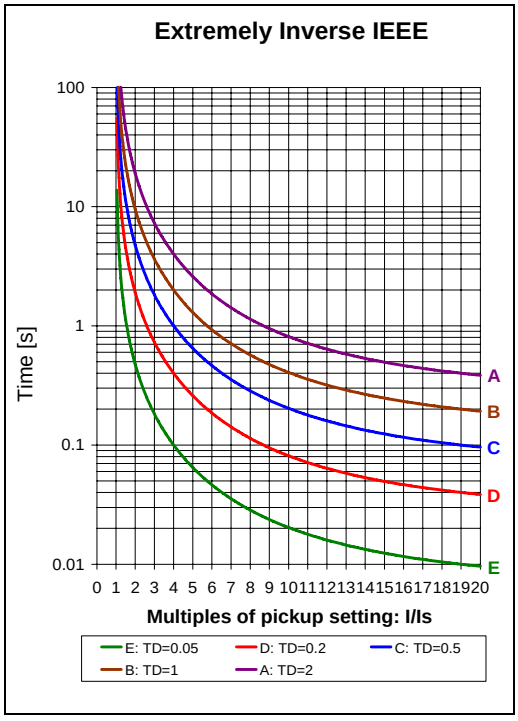
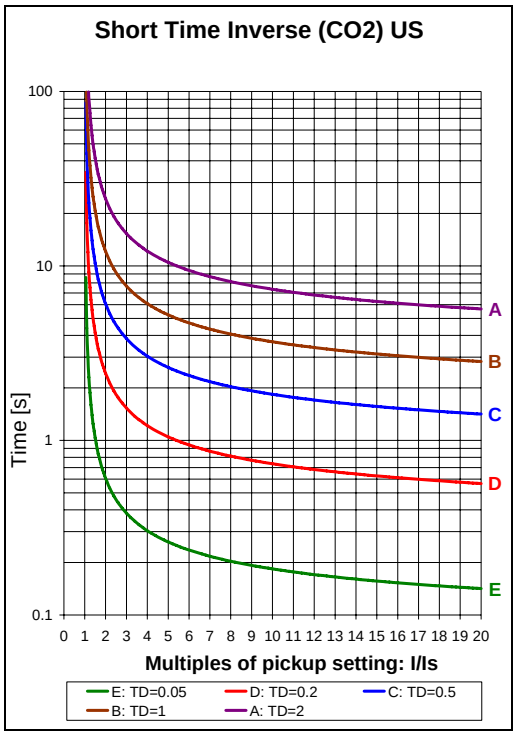
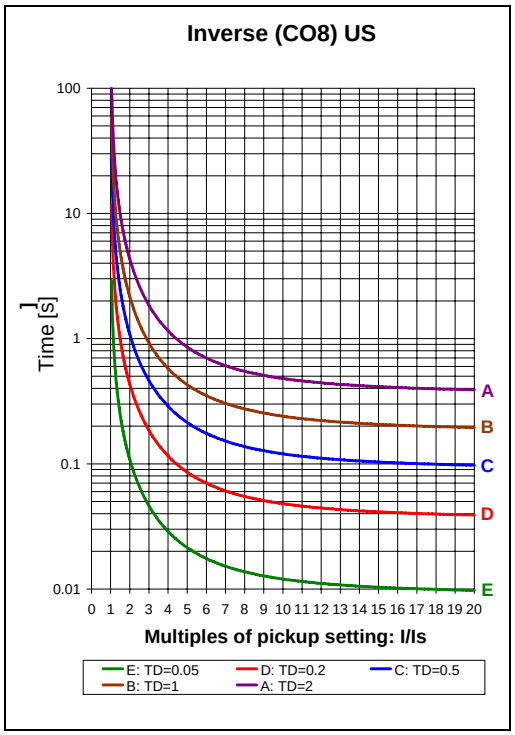
Multiples of pickup setting: I/Is
E: TD=0.05
D: TD=0.2
C: TD=0.5
B: TD=1
A: TD=2


Extremely Inverse IEEE
100
10
1
0.1
0.01
Time [s]
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
A
B
C
D
E
Multiples of pickup setting: I/Is
E: TD=0.05
D: TD=0.2
C: TD=0.5
B: TD=1
A: TD=2





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Reset Characteristic

IEEE/US/IEC

The IEEE/US/IEC curves may have an inverse time reset characteristic or instantaneous reset. The following equation can used to calculate the inverse reset time for IEEE/US/IEC curves:

IEC:

$$reset\ time = TMS \cdot \frac{tr}{1 - M^2}$$

IEEE and US:

$$reset\ time = TD \cdot \frac{tr}{1 - M^2}$$

where:

TD = Time dial setting for IEEE/US curves [s]

TMS = Time multiplier setting for IEC curves [s]

Is = Current threshold setting [A]

M = I/Istr

tr = Constant

Type of Curve	Standard	tr
Standard Inverse Time (SI)	IEC	12.1
Very Inverse Time (VI)	IEC	43.2
Extremely Inverse Time (EI)	IEC	80
Long Time Inverse (LTI)	UK	0
Short Time Inverse (STI)	UK	0
Rectifier (Rect)	UK	0
Moderately Inverse Time (MI)	IEEE	4.9
Very Inverse Time (VI)	IEEE	21.6
Extremely Inverse Time (EI)	IEEE	29.1
Time Inverse (CO8)	US	5.95
Short Time Inverse (CO2)	US	2.261

RI curve

The RI curve (electromechanical) has been included in the first stage characteristic setting options for phase overcurrent and earth fault protections. The curve is represented by the following equation.

RI-Inverse Time: $t = TMS \cdot \frac{1}{0.339 - \frac{0.236}{M}}$;

Inverse Time: $t = TMS \cdot \frac{1}{0.339 - \frac{0.236}{M}}$;

2.2 Earth fault protection

The Earth fault element operates from a measured earth fault current quantity.

The first stage of overcurrent protection has time-delayed characteristics which are selectable between inverse definite minimum time (IDMT), or definite time (DMT). The second stage has a definite time characteristic only.

The type of characteristics are the same as for phase protection elements:

- IEC SI: Standard Inverse Time
- IEC VI: Very Inverse Time
- IEC EI: Extremely Inverse Time
- UK LI: Long Time Inverse
- UK STI: Short Time Inverse
- UK Rect: Rectifier
- RI: Electromechanical Inverse
- IEEE MI: Moderately Inverse Time
- IEEE VI: Very Inverse Time
- IEEE EI: Extremely Inverse Time
- US CO2: Short Time Inverse
- US CO8: Time Inverse

The mathematical formulae and curves for the twelve Inverse Time characteristics available with the P115 are presented in section 1.1 of this chapter.

The IEEE/US/IEC curves may have an inverse time reset characteristic, DMT delayed or instantaneous reset (refer to section 1.1 of this chapter).

Depending on the connection of the e/f CT to the current terminals, e/f current can supply P115 (terminals 7 and 9) or not supply the P115 (terminals 8 and 9) (refer to section 8 of the Installation chapter of this manual).

2.3 Unbalance protection

The unbalance element is based on the difference of phase currents in relation to the average value of the 3-phase current.

The unbalanced overcurrent protection has definite time (DMT) time-delayed characteristics.

Current unbalance ($Iasym$) is derived from the 3 phase currents in the following way:

$$Iasym = \max\left(\left|I_A - \frac{I_A + I_B + I_C}{3}\right|, \left|I_B - \frac{I_A + I_B + I_C}{3}\right|, \left|I_C - \frac{I_A + I_B + I_C}{3}\right|\right)$$

Where:

I_A : RMS value in phase A,

I_B : RMS value in phase B,

I_C : RMS value in phase C,

2.4 External Trip via Opto Input

For some applications it is necessary to issue a CB trip via a binary input. Any input configured to AUX1 or AUX2 can be used to that effect.

Tripping is instantaneous.

Auxiliary voltage connected to such a configured Input energizes output relays configured for any trip or AUX1 and/or AUX2 function.

The Low Energy Trip Coil is activated and configured to any trip or AUX1 and/or AUX2 function.

2.5 Blocked overcurrent scheme logic

Each stage of the phase protection element can be blocked via an appropriately configured binary input set to “Blocking scheme” function.

2.6 Reset of latched LEDs and outputs

How latched LEDs and outputs are reset is determined by the inputs assigned to the resetting of latched LED. Output resets can be made via external inputs, pressing the "C" clear key on the P115's front panel if LCD display shows default window or via the communication port.

2.7 Circuit Breaker Failure Function (CBF)

Protection current stages configured to trip – tI>, tI>>, tI>>>, tIN>, tIN>>, tIasym> and CBF Ext. (binary input) – starts the set time delay. Resetting of the CBF timer is done via undercurrent criteria and protection reset criteria.

OP

AP

APPLICATION NOTES

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

AP

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1. INTRODUCTION

1.1 Protection of feeders

The secure and reliable distribution of power within a network is heavily dependent upon the integrity of the underground cables which link the various sections of the network together. As such, the associated protection system must also provide both secure and reliable operation.

The most common fault conditions, on both MV transformers and cables, are short circuit faults. Such faults may occur between phases but will most often involve one or more phases becoming short circuit to earth. Faults of this nature require the fastest possible fault clearance times but at the same time allowing suitable co-ordination with other downstream protection devices.

The effect of fault resistance is more pronounced on lower voltage systems, resulting in potentially lower fault currents, which in turn increases the difficulty in the detection of high resistance faults. In addition, many distribution systems use earthing arrangements designed to limit the passage of earth fault current. Methods such as resistance earthing, Petersen Coil earthing or insulated systems make the detection of earth faults difficult. Special protection requirements are often used to overcome these problems.

The CT-powered P115 is used in MV switchboards with circuit breakers to protect distribution transformers, feeders, and lines in local and industrial power systems. The small compact case allows this relay to be used in these situations.

Due to the dual powered function, P115 can be used as back-up protection of HV/MV transformers.

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide SFTY/4L M/E11 or later issue, OR the safety and technical data section of the technical manual and also the ratings on the equipment rating label.

For safety reasons, no work must be carried out on the P115 until all power sources to the unit have been disconnected.

2. APPLICATION OF INDIVIDUAL PROTECTION FUNCTIONS

The following sections detail individual protection functions in addition to where and how they may be applied. Each section provides some worked examples on how the settings are applied to the relay.

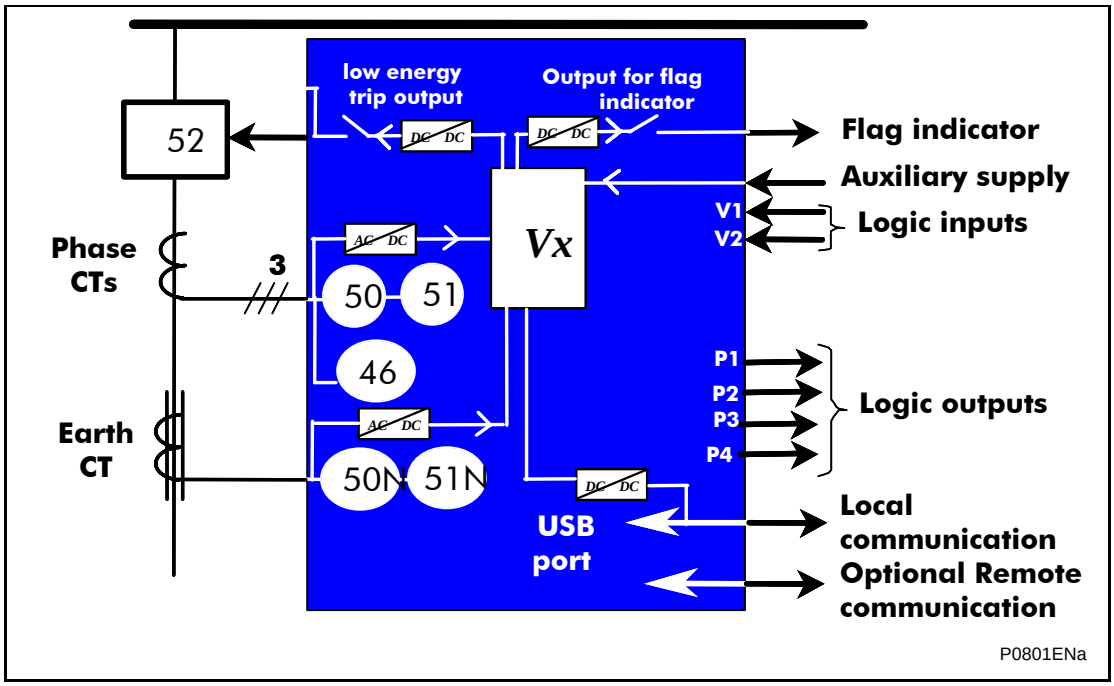

Figure 1: P115 single-line functional diagram (all options are included)

2.1 Overcurrent protection

Overcurrent relays are the most commonly used protective devices in any industrial or distribution power system. They provide main protection to both feeders and busbars when unit protection is not used. They are also commonly applied to provide back-up protection when unit systems, such as pilot wire schemes, are used.

There are a few application considerations when applying overcurrent relays.

2.1.1 Transformer magnetizing inrush

When applying overcurrent protection to the MV side of a power transformer it is usual to apply a high set instantaneous overcurrent element in addition to the time delayed low-set, to reduce fault clearance times for MV fault conditions. Typically, this will be set to approximately 1.3 times the LV fault level, so that it will only operate for MV faults. A 30% safety margin is sufficient due to the low transient overreach. Transient overreach defines the response of a relay to DC components of fault current and is quoted as a percentage.

The second requirement for this element is that it should remain inoperative during transformer energization, when a large primary current flows for a short period during switch-on. In most applications, the requirement to set the relay above the LV fault level will automatically result in settings that will be above the level of magnetizing inrush current.

Both overcurrent stages operate on True RMS component. Hence, for the second overcurrent stage in P115 relays, it is possible to apply settings corresponding to 35% of the peak inrush current, whilst maintaining stability for the condition.

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2.1.2 Application of timer hold facility for IEC/IEEE/US IDMT characteristics

This feature may be useful in certain applications, for example when grading with upstream electromechanical overcurrent relays, which have inherent reset time delays. Setting the hold timer to a value other than zero, delays the resetting of the protection element timers for this period, thus allowing the element to behave similarly to an electromechanical relay.

Another possible situation where the timer hold facility may be used to reduce fault clearance times is where intermittent faults may be experienced. An example of this may occur in a plastic insulated cable. In this application it is possible that the fault energy melts and reseals the cable insulation, thereby extinguishing the fault. This process repeats to give a succession of fault current pulses, each of increasing duration with reducing intervals between the pulses, until the fault becomes permanent.

When the reset time of the overcurrent relay is instantaneous, the relay will be repeatedly reset and unable to trip until the fault becomes permanent. By using the Timer Hold facility for IDMT characteristics the relay will integrate the fault current pulses, thereby reducing fault clearance time.

For IDMT it is possible to set the timer hold facility based on the following formulae:

IEC: $reset\ time = TMS \cdot \frac{tr}{1 - M^2}$

IEEE and US: $reset\ time = TD \cdot \frac{tr}{1 - M^2}$

where:

$$M = \frac{I}{Is}$$

I = Measured current in [A]

TMS = Time setting [s]

Is = Current threshold setting [A]

Type of Curve	Standard	tr
SI - Standard Inverse Time Characteristic	IEC	12.1
VI - Very Inverse Time Characteristic	IEC	43.2
EI - Extremely Inverse Time Characteristic	IEC	80
LTI - Long Time Inverse Characteristic	UK	0
STI - Short Time Inverse Characteristic	Schneider Electric	0
Rect - Rectifier Characteristic	UK	0
MI - Medium Inverse Time Characteristic	IEEE	4.9
VI - Very Inverse Time Characteristic	IEEE	21.6
EI - Extremely Inverse Time Characteristic	IEEE	29.1
CO8 - Short Time Inverse Characteristic	US	5.95
CO2 - Inverse Characteristic	US	2.261

Table 1: The value of “tr” for IDMT characteristics

2.1.3 Setting guidelines

When applying the overcurrent protection provided in the P115 relays, standard principles should be applied in calculating the necessary current and time settings for co-ordination The Network Protection and Automation Guide (NPAG) textbook offers further assistance. The example detailed below shows a typical setting calculation and describes how the settings are applied to the relay.

Assume the following parameters for a relay feeding an LV switchboard:

CT Ratio = 500 A/1 A

Full load current of circuit = 440 A

Slowest downstream protection = 100 A Fuse

The current setting employed on the P115 relay must account for both the maximum load current and the reset ratio of the relay itself:

I> must be greater than: (440 A/0.95)/500 A = 0.9263 In

I> must be greater than: 0.9263 In

For setting range 0.2-4 In step is 0.01 In, so the closest I> set value=0.93 In:

A suitable time delay characteristic can now be chosen. When coordinating with downstream fuses, the applied relay characteristic should be closely matched to the fuse characteristic. Therefore, assuming IDMT co-ordination is to be used, an IEC Extremely Inverse (EI) time characteristic would normally be chosen.

Finally, a suitable time multiplier setting (TMS) must be calculated and entered.

MV/LV transformer application

Example:

Transformer:

Snom = 1000 kVA

Unom = 6 kV

CT ratio : 100 A/1 A

$$I_{nom} = \frac{S_{nom}}{\sqrt{3} \cdot U_{nom}} = \frac{1000kVA}{\sqrt{3} \cdot 6kV} = 96A$$

Where:

I_{nom} - nominal current of the transformer

S_{nom} - nominal power of the transformer

U_{nom} - nominal phase-phase voltage

Short circuit I>>

Primary value setting: 1.5kA

I>> current stage: $I_{>>} = 1500A/100A = 15[In]$

$I_{>>}\_set\_value$: 15In

Where:

$I_{>>}\_set\_value$: setting value of the short-circuit overcurrent stage

Overcurrent I>

Overcurrent stage I> should be set above the normal load current

If the primary setting value of I> is equal to 172 A, the set value is calculated as follows:

$$I_{>} = 172A/100A = 1.72 \cdot In$$

2.1.4 DT threshold

The first and the second stage of the overcurrent characteristic for phase current (I>, I>>) and e/f current (IN>) can be configured with a definite time (DT) delay or an IDMT characteristic.

The third O/C stage (I>>>) and the second e/f (IN>>) stage are DT only.

2.1.5 IDMT threshold

The first and the second phase (I>, I>>) and e/f (IN>) overcurrent threshold can be selected with an independent definite maximum time (IDMT) characteristic.

The time delay in relay operation is calculated with a mathematical formula which depends on the relay current and TMS (IEC and UK) or TD (IEEE/ANSI and US) values.

There are twelve inverse time characteristics available:

- SI: Standard Inverse Time Characteristic (IEC)
- VI: Very Inverse Time Characteristic (IEC)
- EI: Extremely Inverse Time Characteristic (IEC)
- LTI: Long Time Inverse Characteristic (UK)
- STI: Short Time Inverse Characteristic (Schneider Electric)
- RC: Rectifier Characteristic (UK)
- MI: Medium Inverse Time Characteristic (IEEE/ANSI)
- VI: Very Inverse Time Characteristic (IEEE/ANSI)
- EI: Extremely Inverse Time Characteristic (IEEE/ANSI)
- CO2: Short Time Inverse Characteristic (US)
- CO8: Inverse Characteristic (US)
- RI: Electromechanical Inverse Characteristic

The mathematical formulae and curves for the twelve Inverse Time characteristics available with the P115 are presented in chapter OP (“Operation”).

2.2 Protection of silicon rectifiers

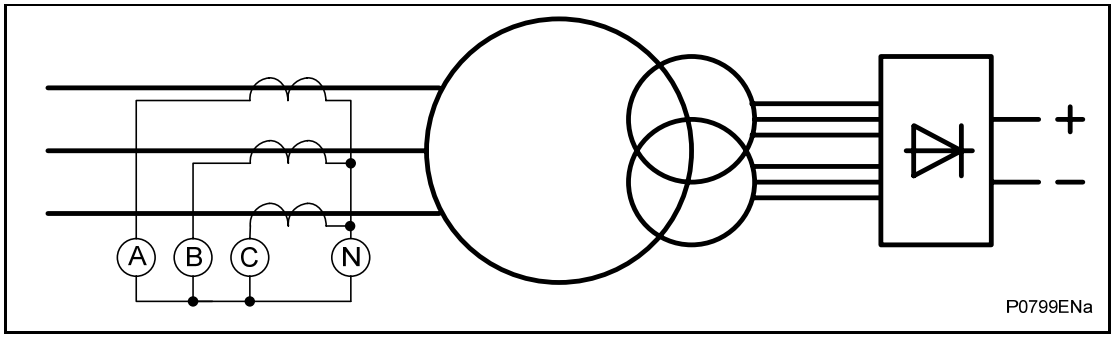

Figure 2: Protection of silicon rectifiers

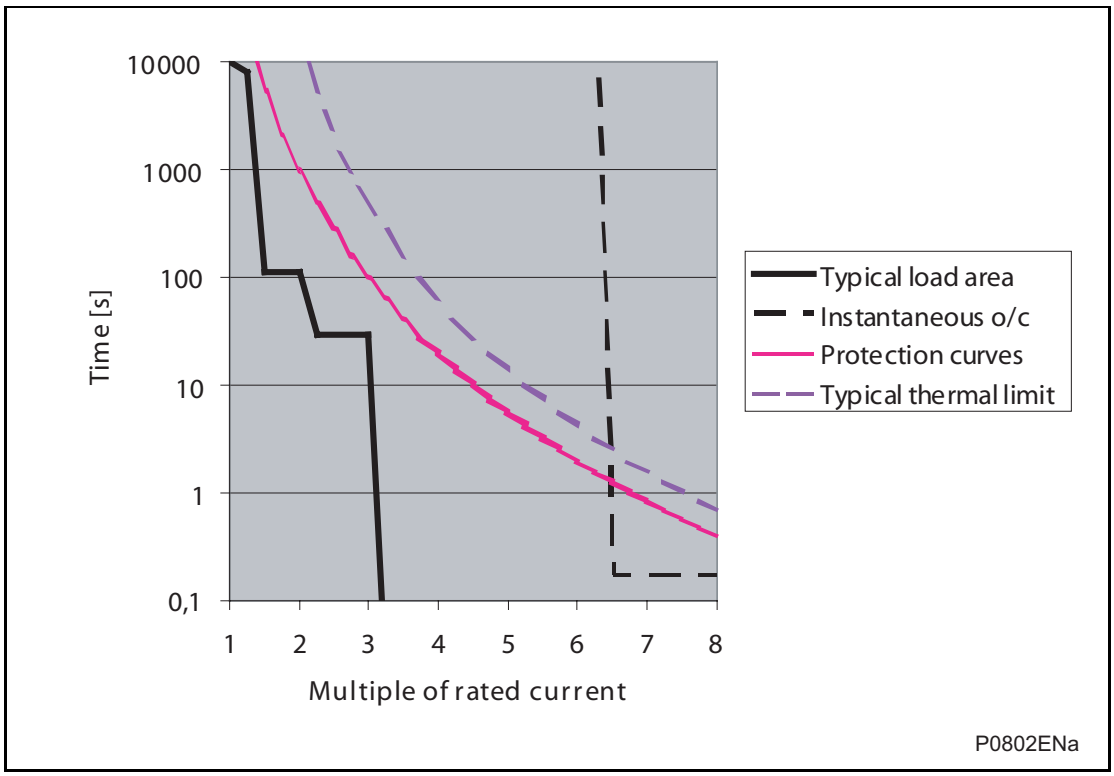

Figure 3: Matching curve to load and thermal limit of rectifier

The rectifier protection feature is based upon the inverse time/current characteristic as used in the MCTD01 (Silicon Rectifier Protection Relay) and the above diagrams show a typical application.

The protection of a rectifier differs from the more traditional overcurrent applications in that many rectifiers can withstand relatively long overload periods without damage, typically 150% for 2 hours and 300% for 1 min.

The I> setting should be set to typically 110% of the maximum allowable continuous load of the rectifier. The relay gives start indications when the I> setting has been exceeded, but this is of no consequence, as this function is not used in this application. The rectifier curve should be chosen for the inverse curve as it allows for relatively long overloads even with a 110% I> setting.

Typical settings for the TMS are:

Light industrial service TMS = 0.025

Medium duty service TMS = 0.1

Heavy duty traction TMS = 0.8

The high set is typically set at 8 times rated current as this ensures HV AC protection will discriminate with faults covered by the LV protection. However, it has been known for the high set to be set to 4 or 5 times where there is more confidence in the AC protection. Use of the thermal element to provide protection between 70% and 160% of rated current could enhance the protection. It is also common practice to provide restricted earth fault protection for the transformer feeding the rectifier. See the appropriate section dealing with restricted earth fault protection.

2.3 Earth fault protection

Earth fault (E/F) current is measured on the e/f input.

Depending on the connection on the terminals e/f input can supply P115 (terminals 7 and 9) or not supply the P115 (terminals 8 and 9).

Two stages are available: IN> and IN>>. The first stage has IDMT or DT characteristics. The types of characteristics are the same as for I> (refer to section 2.1.5).

If the e/f CT is connected to terminals 7 and 9 and auxiliary voltage supply is not connected to terminals 11-12, the current on e/f input has to be greater than 0.2Ien to supply P115.

2.3.1 Calculation of the required E/F settings

The setting value of E/F overcurrent protection should be greater (with safety margin) than the charging currents flowing in the protected line to prevent an earth fault in other parts of the system tripping the relay. The value of the safety coefficient depends on the application and accuracy of obtained earth fault current value (typically : 1.5 to 2.5).

2.4 External trip

Binary Input can be configured to CB trip by using AUX1 or AUX2 functions.

AUX1 and AUX2 functions have a timer so a trip can be time-delayed.

tAUX1 and tAUX2 can be configured to:

- RL1,
- RL2,
- RL3,
- RL4,
- Trip (protection trip),
- Alarm signal,
- Programmable LEDs.

If it is configured to Trip (protection trip), tAUX1 and/or tAUX2 lit “Trip” LED.

2.5 Blocked overcurrent protection

Blocked overcurrent protection involves the use of start contacts from downstream relays wired onto blocking inputs of upstream relays. This allows identical current and time settings to be employed on each of the relays involved in the scheme, as the relay nearest to the fault does not receive a blocking signal and hence trips discriminatively. This type of scheme therefore reduces the amount of required grading stages and consequently fault clearance times.

The principle of blocked overcurrent protection may be extended by setting fast acting overcurrent elements on the incoming feeders to a substation which can then be blocked by start contacts from the relays protecting the outgoing feeders. The fast acting element is thus allowed to trip for a fault condition on the busbar but is stable for external feeder faults by means of the blocking signal. This type of scheme therefore provides much reduced fault clearance times for busbar faults than would be the case with conventional time graded overcurrent protection. The availability of multiple overcurrent and earth fault stages means that back-up time graded overcurrent protection is also provided. This is shown in Figures 4

and 5. In incomer for blocking of higher stage I>> input L1 should be used, configured to "blocking I>>" function.

The feeder start contact should be configured to the I>> stage.

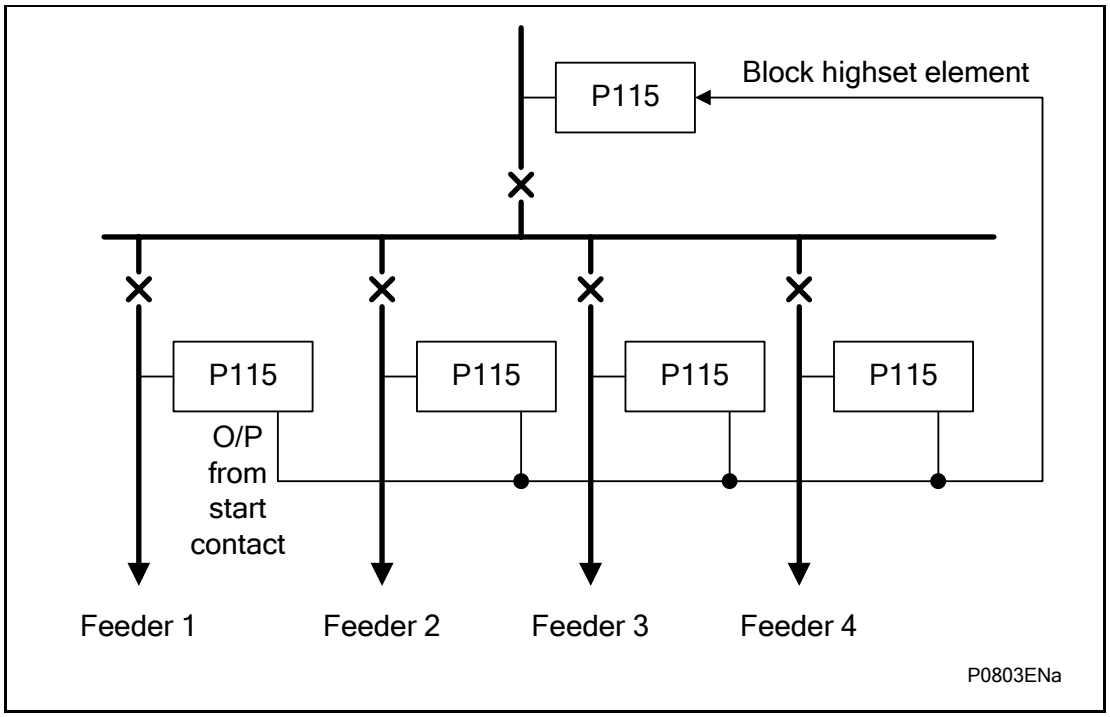

Figure 4: Simple busbar blocking scheme

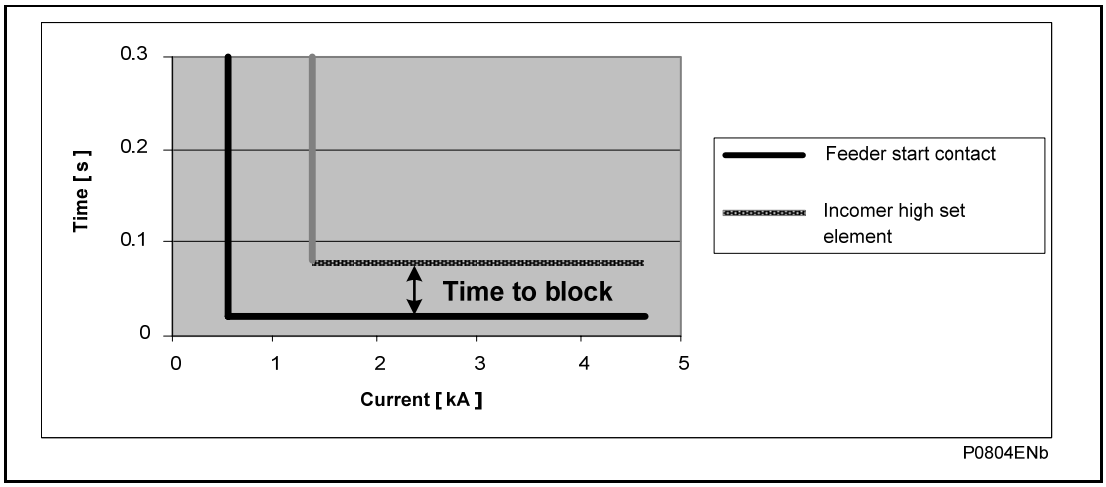

Figure 5: Time grading in the simple busbar blocking scheme

For further guidance on the use of blocked overcurrent schemes refer to Schneider Electric.

Any binary input can be configured to block the following protection functions:

I>, I>>, I>>>, IN>, IN>>, AUX1, AUX2 and CBF.

The programmed binary input blocks the timer and start signals.

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2.6 Circuit breaker fail protection (CBF)

Following the inception of a fault one or more main protection devices will operate and issue a trip output to the circuit breaker(s) associated with the faulted circuit. Operation of the circuit breaker is essential to isolate the fault, and prevent damage / further damage to the power system. For transmission/sub-transmission systems, slow fault clearance can also threaten system stability. It is therefore common practice to implement circuit breaker failure protection, which monitors that the circuit breaker has opened within a reasonable time. If the fault current has not been interrupted following a set time delay from the circuit breaker's trip initiation, breaker failure protection (CBF) will operate.

CBF operation can be used to back-trip upstream circuit breakers to ensure that the fault is isolated correctly. CBF operation can also resets all start output contacts, ensuring that any blocks asserted on upstream protection are removed.

2.6.1 Reset mechanisms for breaker fail timers

It is common practice to use low set undercurrent elements in protection relays to indicate that the circuit breaker's poles have cleared the fault or load current, as required. This covers the following situations:

- Where a circuit breaker's auxiliary contacts are defective, or cannot be relied upon to definitely indicate that the breaker has tripped.
- Where a circuit breaker has started to open but has become jammed. This may result in continued arcing at the primary contacts, with an additional arcing resistance in the fault current path. Should this resistance severely limit fault current, the initiating protection element may reset. Thus, reset of the element may not give a reliable indication that the circuit breaker has opened fully.

For any protection function requiring current to operate, the relay uses operation of undercurrent elements (I<) to detect that the necessary circuit breaker poles have tripped and reset the CB fail timers. However, the undercurrent elements may not be reliable methods of resetting circuit breaker fail in all applications. For example:

- With non-current operated protection, such as CB Ext. Here, I< only gives a reliable reset method if the protected circuit would always have load current flowing. Detecting drop-off of the initiating protection element might be a more reliable method.
- With non-current operated protection, such as CB Ext. Again using I< would rely upon the feeder normally being loaded. Also, tripping the circuit breaker may not remove the initiating condition from the busbar, and hence drop-off of the protection element may not occur. In such cases, the position of the circuit breaker auxiliary contacts may give the best reset method.

Resetting of the CBF is possible from a breaker open indication (from the relay’s pole dead logic) or from a protection reset. In these cases resetting is only allowed provided the undercurrent elements have also reset.

2.6.2 Typical settings

2.6.2.1 Breaker fail timer settings

Typical timer settings to use are as follows:

CB fail reset mechanism	tBF time delay	Typical delay for 2 cycle circuit breaker
Initiating element reset	CB interrupting time + element reset time (max.) + error in tBF timer + safety margin	50 + 50 + 10 + 50 = 160 ms
CB open	CB auxiliary contacts opening/ closing time (max.) + error in tBF timer + safety margin	50 + 10 + 50 = 110 ms
Undercurrent elements	CB interrupting time + undercurrent element (max.) + safety margin operating time	50 + 25 + 50 = 125 ms

Note that all the CB Fail resetting methods involve the operation of the undercurrent elements. Where element reset or CB open resetting is used the undercurrent time setting should still be used if this proves to be the worst case.

The examples above consider direct tripping of a circuit breaker. Note that where auxiliary tripping relays are used, an additional 10-15ms must be added to allow for trip relay operation.

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2.6.2.2 Breaker fail undercurrent settings

The phase undercurrent settings (I<) must be set less than load current, to ensure that I< operation indicates that the circuit breaker pole is open. A typical setting for overhead line or cable circuits is 20% In, with 5% In common for generator circuit breaker CBF.

The standard earth fault undercurrent element must be set to less than the trip setting, typically as follows:

IN< = (IN> trip) / 2

2.7 Minimum tripping time

The minimum tripping time when the relay is switched on to a fault is subject to the fault current level.

When the current is greater than the fault current level by 0.2 x In (Ien) ("hot start") the minimum trip time can be defined as follows:

Time delay setting + Operation time (measuring algorithm time delay + time to decision + energizing time of output contact).

Typical operation time: ≤ 40 ms

The minimum setting for the DT time delay (I>>>) is: 0 ms for overcurrent and 0 ms for earth fault. For I>, I>> and IN>>, the minimum time delay setting is 0.02 s.

The minimum tripping time for the "hot start" (capacitors are charged within the unit) for 0ms set time delay is: 0 ms + 40 ms = 40 ms

If there was no current flowing through the relay terminals before the occurrence of a fault and that a fault condition occurs, or if the current in all the analog inputs is lower than 0.2 In (0.2 Ien), the minimum tripping time from the "cold start" (capacitors not charged) with a 40 ms set time delay is equal to 0 ms + 40 ms + time correction value.

Time correction value (measured at the output contacts):

(i) Hardware version P115746x0xxxxxx (without energy output for the low energy tripping coil)

- for all types of fault (1, 2, 3-phase): ≤ 25 mA,
- except 1-phase fault currents below 1.6 In (Ien): ≤ 30 mA,

(ii) Hardware version P115746x1xxxxxx (with energy output for the low energy tripping coil, 24 Vdc: 0.1 W) and P115746x2xxxxxx (with energy output for the low energy tripping coil, 12Vdc: 0.02W):

- for faults currents below 0.6 In (Ien):
  - 1-phase fault: ≤ 60 ms
  - 2-phase fault: ≤ 60 ms
  - 3-phase fault: ≤ 30 ms
- for all types of fault currents above 0.6 In (Ien) (1, 2, 3-phases): ≤ 30 ms

For P115 without low energy tripping coil output (P115746x0xxxxxx) the minimum tripping time from the "cold start" with a 0 ms set time delay is equal to
< 0 ms + 40 ms + 30 ms= 70 ms

Typically it is around 65 ms.

The correction time measured on the energy outputs is 6ms shorther than the time measured on the output contacts.

3. CT REQUIREMENTS

For the conventional case of a resistive load, the voltage at the secondary winding of the transformer is proportional to the primary current, therefore the error remains constant.

In the case of a MiCOM P115 self-powered protection relay, this no longer applies, since the voltage at the input of the protection circuit is in a non-proportional ratio to the input current.

The best solution to check whether the MiCOM P115 relay is adapted to a given CT is to have available the magnetization curve and the internal resistance of the CT in question.

To guarantee good accuracy at low current levels, the magnetizing current of the CT must be low. In other words, the input voltage of the relay must be sufficiently low compared with the knee-point voltage Vk of the CT.

The following sections show the ac burden of the P115 MiCOM relay and, taking into account the magnetizing curve of a CT, it is then possible to determine the accuracy of the system as a whole for the entire current range: P115 + associated CT.

3.1 Recapitulation of the current transformer's characteristics

3.1.1 Characterization of a current transformer

The characteristics of a protection relay CT are based on:

- Its rated output burden expressed in VA, its relevant accuracy class (5P or 10P) and the **accuracy limit current** (5 In, 10 In, 15 In, 20 In). The **accuracy limit factor (K)** is the ratio between the precision limit current and the nominal current rating.
- Naturally, the transformation ratio of the CT is to be added to this. This ratio is the ratio of the primary current to the secondary current **I1/I2**. The secondary current rating is generally 1 A or 5 A.
- Other characteristics such as the insulating voltage or the thermal behavior are also taken into account.

Standard BS 3938 proposes a specification identical to that of IEC 185 for class P transformers. The CT is characterized in accordance with a second class known as X class (Cx) which, in addition to the calculated ratio, requires a knee-point voltage **Vk** and an internal resistance **Rct**.

The following quantities are associated with the magnetization curve of a CT:

- The knee-point voltage **Vk**, which is determined by the point on the curve V=f (Im) beyond which an increase of 10% in the voltage V results in a 50% increase of the magnetizing current.
- The voltage related to the accuracy limit of the CT.

  - For a 5PK CT (accuracy class 5P, accuracy limit factor K):

  At the saturation voltage **Vs1** we will have a 5% accuracy on the current K * In.

  - For a 10PK TC (accuracy class 10P, accuracy limit factor K):

  At the saturation voltage **Vs2** we will have a 10% accuracy on the current K * In.

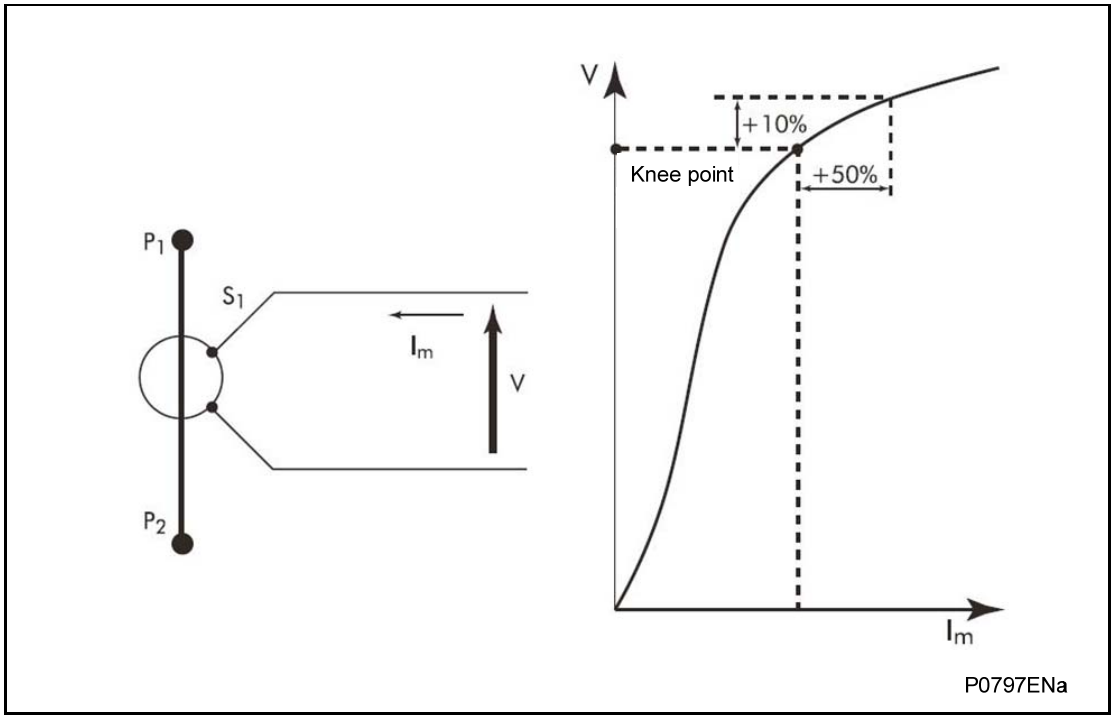

Figure 6: Definition of the magnetizing curve's knee-point

With the materials generally used to manufacture current transformers, we have:

Vk corresponds to 1.4 tesla

Vs1 corresponds to 1.6 tesla

Vs2 corresponds to 1.9 tesla

3.1.2 Equivalent diagram of a current transformer

The equivalent diagram of a CT is indicated below:

- CT ratio: n2/n1
- L_m : magnetization self-induction coil of the CT
- I_m : magnetizing current
- I_1 : primary current
- I_2 : secondary current = I1 * n2 /n1
- I_s : secondary current passing through the load resistance Rp. : $\overrightarrow{I_S} = \overrightarrow{I_2} - \overrightarrow{I_m}$
- Rct : secondary winding resistance of CT (ohms)

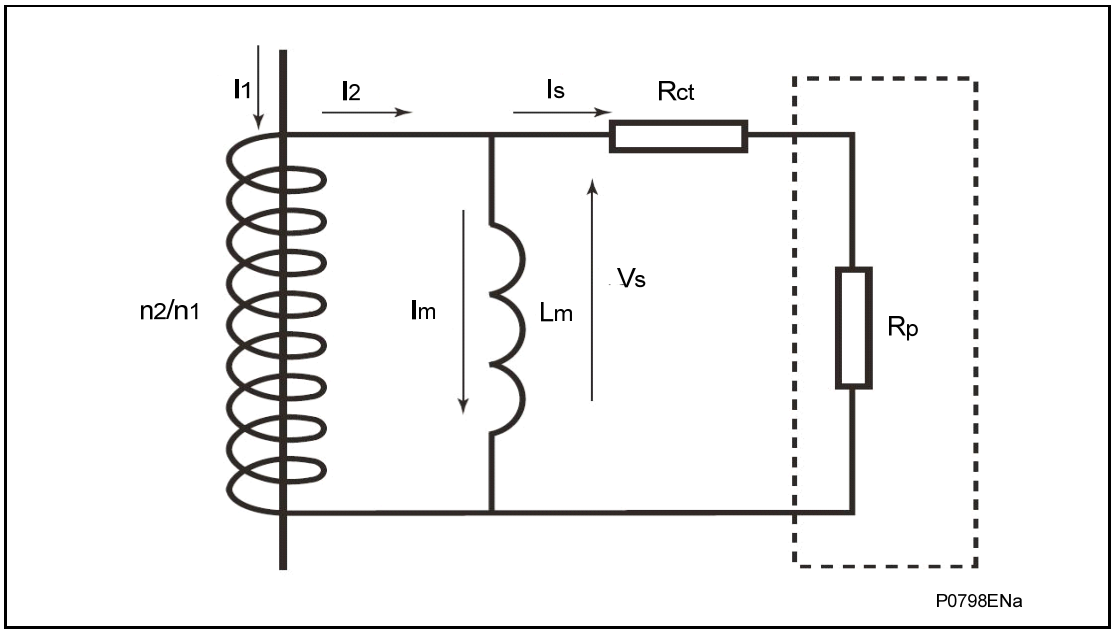

Figure 7: Equivalent diagram of a current transformer

The magnetizing current Im of the transformer depends on the voltage generated at the secondary windings of the transformer.

It is this current that introduces an error signal into the measurement. If the CT were perfect, the magnetizing current would be null.

3.1.3 How to calculate the rated burden, in VA, of a CT based on its characteristic quantities (Vk, Rct)

The saturation voltage is derived using the following formula: Vs = (Rct + Rp) Is

The nominal load impedance of the CT is Rp = Pn /In^2

We have Vs = (Rct + Pn /In^2) Is

Hence: Pn = (Vs/Is - Rct) In^2

- For a transformer with in a **5P** accuracy class: Vs1/Vk = 1.6/1.4

Thus: Vs1 = 1.6/1.4 * Vk, at Is1 equals K * In

Hence: Pn = [(1.6/1.4 * Vk)/K * In - Rct] * In^2

- For a transformer with a 10P accuracy class: Vs2/Vk = 1.9/1.4

thus Vs2 = 1.9/1.4 * Vk, at Is2 equals K * In

Hence: Pn = [(1.9/1.4 * Vk)/K * In - Rct] * In^2

3.1.4 Definition equivalence for common CTs

Since the only constants of a CT are its magnetizing curve, its Rct resistance and its transformation ratio, it is possible to replace a transformer which Pn1 power in VA is of the 5PK1 type with a transformer which Pn2 power in VA is of the 5PK2 type.

Given that the values of Vs1 and Rct are known:

Vs1 = (Rct +Pn1/In^2)*K1 * In = (Rct + Pn2/In^2)*K2 *In

Pi = Rct * In^2 (ohmic loss of CT)

(Pi +Pn1) * K1 = (Pi + Pn2) * K2

Hence K2 = [(Rct * In^2 + Pn1)/ (Rct * In^2 + Pn2)] * K1

3.1.5 How to calculate the knee-point voltage Vk of a CT defined in class **P**

- For a transformer with accuracy class of **5P** : Vs1/Vk = 1.6/1.4

Pn = [(1.6/1.4 * Vk)/K* In - Rct] * In^2

Hence Vk = 1.4/1.6 (Pn/In^2 + Rct) K * In

- For a transformer with a precision class **10P** : Vs2/Vk = 1.9/1.4

Pn = [(1.9/1.4 * Vk)/K* In - Rct] * In^2

Hence Vk = 1.4/1.9 (Pn/In^2 + Rct) K * In.

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3.2 Consumption of MiCOM P115 relays

The MiCOM P115's self- and dual-powered hardware versions (with identical ac burden at their current inputs) have a minimum self-supply starting current of 0.2 In. This minimum level of current is needed on at least one phase in order to enable the MiCOM relay to be correctly self-powered and thus ensure the full capability of its protection functions:

CAUTION: THE FOLLOWING ARE THERMAL CHARACTERISTICS

- 3 In continuous rating
- 40 In during 100 s
- 100 In during 1 s

The P115's current input resistance depends on the value of the current. Table 2 shows the resistance for a single current input per P115: In = 1 A / 5 A, and common connection for a single current input per P115 + current transformer WA-25. For phase-phase and phase-earth fault analysis it is necessary to take into account a double value of the resistance, as shown in Table 2.

I	Rp for a single current input		
	In=1 A	In=5 A	(In=1 A)+WA25
In	Ohms		
0.2	28.9	1.0	21.9
0.3	11.5	0.36	16.7
0.4	6.6	0.27	6.8
0.5	3.8	0.22	3.8
1	0.63	0.12	2.5
10	0.28	0.056	2.2
20	0.28	0.056	2.2
40	0.28	0.056	2.2

Table 2: P115 current input resistance

3.3 Calculation of required CT for MiCOM P115

It is not possible to recommend any CT without detailed information. The decision needs to be based on calculation.

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The following parameters have to be considered:

- Type of CT (nominal power, nominal current and current ratio, internal resistance, nominal accuracy limit factor, class and construction),
- Resistance of wiring (length, cross section, specific resistance of material),
- Resistance of P115 current inputs (as per table 2 in section 3.2).

Two critical cases have to be checked for different types of faults:

- the lowest set current threshold value at which the relay has to operate (minimum current).
- the highest possible short-circuit current, which depends on the maximum short-circuit power on the busbar of the substation (maximum current).

The following equation is used for dimensioning a current transformer:

$$V_{sal} = n_n \cdot I_{sn} \cdot \left(R_{ct} + R_{bn}\right) \geq \frac{I_{psc}}{K_n} \cdot \left(R_{ct} + R_b\right)$$

The current transformer can be dimensioned for the minimum required secondary accuracy limiting voltage acc. to IEC 60044-1, 2.3.4:

$$V_{sal} \geq \frac{I_{psc}}{K_n} \cdot \left(R_{ct} + R_b\right)$$

$$\geq \frac{I_{psc}}{I_{pn}} \cdot I_{sn} \cdot \left(R_{ct} + R_b\right)$$

$$\boxed{V_{sal} \geq K_{ssc} \cdot I_{sn} \cdot \left(R_{ct} + R_b\right)}$$

Alternatively, the current transformer can also be dimensioned for the minimum required rated accuracy limit factor acc. to IEC 60044-1, 2.3.3:

$$n_n \geq \frac{I_{psc}/K_n}{I_{sn}} \cdot \frac{(R_{ct} + R_b)}{(R_{ct} + R_{bn})}$$
$$\geq \frac{I_{psc}}{I_{pn}} \cdot \frac{(R_{ct} + R_b)}{(R_{ct} + R_{bn})}$$

$$n_n \geq K_{ssc} \cdot \frac{(R_{ct} + R_b)}{(R_{ct} + R_{bn})} = K_{ssc} \cdot \frac{(P_{ct} + P_b)}{(P_{ct} + P_{bn})}$$

The actual secondary connected burden Rb is given as follows:

- For phase-to-ground faults: $R_b = 2 \cdot R_l + 2 \cdot R_{rel}$
- For phase-to-phase faults: $R_b = R_l + R_{rel}$

The relay's burden R_{rel} is per table 2 (see section 3.2).
The lead resistance R_l is to be calculated from wire length, cross section and specific resistance.

The relation between secondary accuracy limiting voltage acc. to IEC 60044-1, 2.3.4 and rated accuracy limit factor acc. to IEC 60044-1, 2.3.3 is given as follows:

$$V_{sal} = n_n \cdot \left(\frac{P_{bn}}{I_{sn}} + I_{sn} \cdot R_{ct} \right)$$

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Sample calculation

The following application data are given:

CT ratio 100/1 A

CT nominal power 2.5 VA (R_{bn} = 2.5 Ohm)

CT internal burden R_{CT} = 0.5 Ohm

Lead resistance R_l = 0.01774 Ohm (2m one way, 2.5mm^2 Cu)

Max. short-circuit current: phase-ground = 2 kA = 20 Inom: R_{rel} = 0.28 Ohm
phase-phase = 10 kA = 100 Inom: R_{rel} = 0.28 Ohm

Relay minimum operating current: IN> = 0.2 Inom: R_{rel} = 28.9 Ohm
I> = 1 Inom: R_{rel} = 0.63 Ohm

Phase-ground fault, minimum current:

$$n_n \geq K_d \cdot K_{ssc} \cdot \frac{(R_{ct} + R_b)}{(R_{ct} + R_{bn})} = 0.2 \cdot \frac{0.5 + 2 \cdot (0.01774 + 28.9)}{0.5 + 2.5} = 3.9$$

Phase-ground fault, maximum current:

$$n_n \geq K_d \cdot K_{ssc} \cdot \frac{(R_{ct} + R_b)}{(R_{ct} + R_{bn})} = 20 \cdot \frac{0.5 + 2 \cdot (0.01774 + 0.28)}{0.5 + 2.5} = 7{,}3$$

Phase-phase fault, minimum current:

$$n_n \geq K_d \cdot K_{ssc} \cdot \frac{(R_{ct} + R_b)}{(R_{ct} + R_{bn})} = 1.0 \cdot \frac{0.5 + 0.01774 + 0.63}{0.5 + 2.5} = 0.38$$

Phase-phase fault, maximum current:

$$n_n \geq K_d \cdot K_{ssc} \cdot \frac{\left(R_{ct} + R_b\right)}{\left(R_{ct} + R_{bn}\right)} = 100 \cdot \frac{0.5 + 0.01774 + 0.28}{0.5 + 2.5} = 26.6$$

Overall, a minimum rated accuracy limit factor of 26.6 is required. A typical (standard) value thus would be $n_n = 30$.

4. POSSIBLE CONNECTIONS OF CTs AT THE P115's INPUT

Connection diagrams are given in the Installation chapter (P115/EN IN) of this manual.

4.1 Connection to 3 phase CTs + core balanced CT

4.1.1 Core balanced CT connected to the measurement earth current input (terminals 8 – 9)

This application can be used in systems with a small value of e/f current (isolated or with Petersen coil). To ensure that the P115 is powered during earth fault conditions, the auxiliary voltage supply should be connected to terminals 11 and 12 (Vx). Typically phase to phase ac voltage from substation auxiliary transformer or VT is applied. For the above types of system, the phase to phase voltage does not disappear during earth faults. For phase to phase faults P115 is supplied from the CTs only.

Refer to Application chapter: P115/EN AP, Figure 4.

Advantage:
In this case, a typical core balanced CT can be used.

The earth fault current value has no influence on the CB tripping.

Disadvantage:
Additional Vx powering from an ac voltage source is required to trip in case of an e/f.

4.1.2 Core balanced CT connected to the self-powered earth current input (terminals 7 - 9)

Advantage:
This connection is advantageous when the transformation ratio of the core CT is less than that of the phase CTs (greater sensitivity demand on the earth range). This enables the fault at the earth current input of the protection to be perceived even if this fault is not of sufficient level (0.2 In) to supply the protection via the phase currents, in which case the fault could self-power the protection through the earth current input.

Disadvantage:
The core CT must be appropriately dimensioned, that is it must have few turns, to ensure good sensitivity.

4.1.3 Connection to 2 phases CTs + core balanced CT

Refer to Application chapter: P115/EN AP, Figure 5.

Advantage:
Only 2 CTs are used, resulting in saving one phase CT. The third phase is reformed by the wiring.

Disadvantage:
The phase and earth CTs must be suitably overdimensioned. The core CT must be connected to the supply input of the earth current input (terminals 7 - 9).

We assume that the system is balanced.

4.2 The earth current input is connected to the summation of the 3 phase CTs

Refer to Application chapter: P115 EN AP, Figure 3.

Advantage:
In this case, the earth current is detected by summing the 3 phase currents, the use of a core CT is therefore not required. The summing operation is performed at terminals 8 - 9 of the earth current input.

It is not necessary to supply the relay via the earth current input. However, an additional supply (shown Figure 3) via the earth fault current will provide more energy to the P115. Therefore the CT starts supplying the P115 when the current drops below 0.2 Ien (refer to the Technical Data chapter P115/EN TD).

Disadvantage:
Less sensitivity than the core CT connection.

5. AUXILIARY SUPPLY FUSE RATING

In the Safety section of this manual, the maximum allowable fuse rating of 16A is quoted. To allow time grading with fuses upstream, a lower fuse link current rating is often preferable. Use of standard ratings of between 6A and 16A is recommended. Low voltage fuse links, rated at 250V minimum and compliant with IEC60269-2 general application type gG, with high rupturing capacity are acceptable. This gives equivalent characteristics to HRC "red spot" fuses type NIT/TIA often specified historically.

The table below recommends advisory limits on relays connected per fused spur. This applies to the MiCOM P115**,** as these have inrush current limitation on switch-on, to conserve the fuse-link.

Maximum Number of MiCOM P115 Relays Recommended Per Fuse				
Battery Nominal Voltage	6 A	10 A Fuse	15 or 16 A Fuse	Fuse Rating > 16 A
24 to 48 Vac/dc	2	4	6	Not permitted
60 to 240 Vac/ 60 to 250 Vdc	6	10	16	Not permitted

Alternatively, miniature circuit breakers (MCB) may be used to protect the auxiliary supply circuits.

MEASUREMENTS AND RECORDING

MR

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P1150D**

MR

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MR

1. MEASUREMENTS AND RECORDING

1.1 Introduction

The P115 is equipped with integral fault recording facilities suitable for analysis of complex system disturbances. Fault records can be read out by setting software MiCOM S1 via the USB port accessible on the P115 front panel. The USB port offers a communications facility to the P115.

Communications can be established via the USB port even if the P115 is supplied neither by the CT nor by the auxiliary voltage.

Access to the USB port is protected by means of a plastic cover.

1.2 Event records

The relay records and time tags up to 100 events and stores them in non-volatile FRAM memory. This enables the system operator to establish the sequence of events that occurred within the relay following a particular power system condition, switching sequence etc. When the available space is exhausted, the oldest event is automatically overwritten by the most recent.

The real time clock within the relay provides the time tag for each event, to a resolution of 1 ms.

The event records are available for remote viewing, via the communications ports RS485 or USB.

For extraction from a remote source via communications ports, refer to the SCADA Communications section (P115/EN CT), where the procedure is fully explained.

Types of event

An event may be a change of state of a control input or output relay, a trip condition, etc. The following sections show the various items that constitute an event:

Change of state of binary inputs

If one or more of the binary inputs has changed state since the last time that the protection algorithm ran, the new status is logged as an event. The information is available if the event is extracted and viewed via a PC.

Change of state of one or more output relay contacts

If one or more of the output relay contacts have changed state since the last time that the protection algorithm ran, then the new status is logged as an event. The information is available if the event is extracted and viewed via PC.

Relay alarm conditions

Any alarm conditions generated by the relays will also be logged as individual events. The following table shows examples of some of the alarm conditions and how they appear in the event list:

Alarm Condition	Event Text	Event Value
Auxiliary Supply Fail	Vx Fail ON/OFF	Bit position 0 in 32 bit field
CT Supply Fail	CT Supply Fail ON/OFF	Bit position 1 in 32 bit field

The above table shows the abbreviated description that is given to the various alarm conditions and also a corresponding value between 0 and 31. This value is appended to each alarm. It is used by the event extraction software, such as MiCOM S1, to identify the alarm. Either ON or OFF is shown after the description to signify whether the particular condition is operational or has reset.

Protection element trips

Any operation of protection elements,(a trip condition) will be logged as an event record, consisting of a text string indicating the operated element and an event value. Again, this value is intended for use by the event extraction software, such as MiCOM S1.

1.3 Fault records

Each fault record is generated with time stamp.

The following data is recorded for any relevant elements that operated during a fault, and can be viewed in each of the last 5 fault records:

(i) Event Text (the reason for a trip):

Phase Overcurrent:
I> trip
I>> trip
I>>> trip
IN> trip
IN>> trip
Iasym> trip
CB Fail trip
AUX1 trip
AUX2 trip
CB Ext. trip (binary input configured to start the CB Fail logic)

(ii) Event Value:

Per phase record of the current value during the fault: Iφ and measured IN

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Fault records are stored in non-volatile memory (FRAM memory). This type of memory does not require any maintenance (no battery inside the P115). Fault records are stored without any time limitation even if the P115 is not supplied from any power source.

1.4 Measurements

The relay produces a variety of directly measured power system quantities:

IA, IB, IC - RMS values

IN - measured fundamental harmonic only (E/F analogue input)

Iasym - calculated maximal difference between phase current and average value from 3 phase current

The above quantities are used by the protection criteria and by the fault recorder.

MiCOM P115

COMMISSIONING

CM

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

CM

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1. INTRODUCTION

The MiCOM P115 feeder protection relays are fully numerical in design, implementing all protection and non-protection functions in software. The relays employ a high degree of self-monitoring. The commissioning tests do not need to be as extensive as with non-numeric electronic or electro-mechanical relays.

In the commissioning of numeric relays, it is only necessary to verify that the hardware is functioning correctly and that the application-specific software settings have been applied to the relay. It is considered unnecessary to test every function of the relay if the settings have been verified by one of the following methods:

- Extracting the settings applied to the relay using appropriate setting software (preferred method)
- Via the operator interface

Unless previously agreed to the contrary, the customer will be responsible for determining the application-specific settings applied to the relay and for testing of any scheme logic applied by external wiring.

Blank commissioning test and setting records are provided at the end of this chapter for completion as required.

Before carrying out any work on the equipment, the user should be familiar with the contents of the safety guide SFTY/4L M/E11 or later issue, or the safety and technical data section of the technical manual and also the ratings on the equipment rating label.

For safety reasons, no work must be carried out on the P115 until all power sources to the unit have been disconnected.

2. SETTING FAMILIARIZATION

When commissioning a MiCOM P115 relay for the first time, sufficient time should be allowed to enable the user to become familiar with the method by which the settings are applied.

The Getting Started chapter (P115/EN GS) contains a detailed description the P115 relay.

Via the front panel all the settings can be changed (refer to Settings chapter P115 /EN ST of this manual), LEDs and alarms reset, and fault and event records cleared. However, menu cells which have access levels higher than the default level will require the appropriate password to be entered, before changes can be made.

Alternatively, if a portable PC is available together with suitable setting software (such as MiCOM S1), the menu can be viewed a page at a time to display a full column of data and text. This PC software also allows settings to be entered more easily, saved to a file on disk for future reference or printed to produce a setting record. Refer to the PC software user manual for details. If the software is being used for the first time, allow sufficient time to become familiar with its operation.

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3. EQUIPMENT REQUIRED FOR COMMISSIONING

3.1 Minimum equipment required

Multifunctional dynamic current injection test set.

Multimeter with suitable ac current range.

Ensure that the multimeter fuse is not open-circuited if used for CT current measurement.

Multimeter with maximum value recording of the dc voltage (to measure the dc magnitude of the trip pulse).

Continuity tester (if not included in multimeter).

NOTE: Modern test equipment may contain many of the above features in one unit.

4. PRODUCT CHECKS

These product checks cover all aspects of the relay and should be carried out to ensure that the unit has not been physically damaged prior to commissioning, that it is functioning correctly and that all input quantity measurements are within the stated tolerances.

If the application-specific settings have been applied to the relay prior to commissioning, it is advisable to make a copy of the settings to allow their restoration later. This could be done by:

- Obtaining a setting file from the customer.
- Extracting the settings from the relay itself (this again requires a portable PC with appropriate setting software);
- Manually creating a setting record. This could be done using a copy of the setting record located at the end of this chapter to record the settings. As the relay's menu is scrolled through sequentially via the front panel user interface.

4.1 With the relay de-energized

The following group of tests should be carried out without powering the P115 and with the trip circuit and flag indicator isolated.

The current transformer connections must be isolated from the relay for these operations to be carried out.

WARNING: NEVER OPEN CIRCUIT THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL AND COULD DAMAGE INSULATION.

The line current transformers should be short-circuited and disconnected from the relay terminals, using the isolating trip circuit and flag indicator provided. If this is not possible to complete this operation, the wiring to these circuits must be disconnected and the exposed ends suitably short circuited to prevent a safety hazard.

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4.1.1 Visual inspection

The rating information given under the top access cover on the front of the relay should be checked. Check that the relay being tested is correct for the protected line/circuit. Ensure that the circuit reference and system details are entered onto the setting record sheet. Double-check the CT primary current rating, and be sure to record the actual CT setting used.

Carefully examine the relay to check that no physical damage has occurred since installation.

4.1.2 Insulation

Insulation resistance tests are only necessary during commissioning and if they have not been performed during installation.

Isolate all wiring from the earth and test the insulation with an electronic or brushless insulation tester at a dc voltage not exceeding 500V. Terminals of the grouped circuits should be temporarily connected together.

The main groups of relay terminals are:

a) Current transformer circuits,

b) Trip coil and flag indicator outputs

c) Auxiliary voltage supply

d) Binary control inputs (L1 and L2: one circuit)

e) Relay contacts

f) EIA(RS)485 communication port

g) Case earth

The insulation resistance should be greater than 100MΩ at 500V.

On completion of the insulation resistance tests, ensure all external wiring is correctly reconnected to the relay.

4.1.3 External wiring

Check that the external wiring is correct when compared to the relevant relay and scheme diagram. Ensure as far as practical that the phase sequence is as expected. The relay diagram number appears on the rating label on the upper side of the case.

The connections should be checked against the scheme (wiring) diagram.

4.1.4 Auxiliary supply voltage (Vx)

The relay can be operated from either a dc only or ac/dc auxiliary supply depending on the relay's nominal supply rating. The incoming voltage must be within the operating range specified in Table 1.

Without energizing the relay measure the auxiliary supply to ensure it is within the operating range.

Nominal Supply Rating DC [AC rms]		DC Operating Range	AC Operating Range
24 - 48V	[24 - 48V]	19 to 58V	19 to 53V
60 - 250V	[60 - 240V]	48 to 300V	48 to 265V

Table 1: Operational range of auxiliary supply Vx

It should be noted that the relay can withstand an ac ripple of up to 12% of the upper rated voltage on the dc auxiliary supply.

Do not energize the relay or interface unit using the battery charger with the battery disconnected as this can irreparably damage the relay's power supply circuitry.

Energize the relay only if the auxiliary supply is within the specified operating ranges. If a test block is provided, it may be necessary to link across the front of the test plug to connect the auxiliary supply to the relay.

NOTE: Vx nominal supply rating is common to auxiliary voltage supply and binary control inputs

4.2 With the relay energized

The following group of tests verifies that the relay hardware and software are functioning correctly and should be carried out while the P115 is powered.

MV isolators should be opened and the MV side should be connected to the earth to allow safe operation of the CB.

4.2.1 Light emitting diodes (LEDs)

On power up the green LED should have lit up and stayed on indicating that the relay is healthy. The relay has non-volatile memory which remembers the state (on or off) of the alarm, trip and, if configured to latch, LED indicators when the relay was last energized from an auxiliary supply. Therefore these indicators may also lit up when the auxiliary supply is applied.

Latching of LEDs can be configured via MiCOM S1 setting software (USB port) or manually by the front panel

Default configuration of LEDs latching:

- P115 ordering option with auxiliary voltage supply: with latching up to reset via Binary Input appropriately configured or via communication port
- P115 ordering option without auxiliary voltage supply: without latching

NOTE: Above default cofiguration can be changed using MiCOM S1 setting software (USB port)

The eight LEDs are on the front panel of the relay:

- The green *Healthy* LED indicates that the P115 is powered and no internal faults are detected. A flashing LED indicates a hardware problem on the P115.
- Red *Trip* LED: indicates that the time-delay of the protection element set to trip has elapsed
- The red LEDs 3 to 8 are programmable to the following signals:
  - Protection Trip: Trip of any protection element configured to trip
  - Alarm: Indicates that the time-delay of a protection element configured to alarm has elapsed
  - Start I>: start of the first o/c protection stage
  - Start I>>: start of the second o/c protection stage
  - Start I>>>: start of the third o/c protection stage
  - Start IN>: start of the first e/f protection stage
  - Start IN>>: start of the second e/f protection stage
  - Start Iasym>: start of the asymmetry protection element
  - Start AUX1: start of *AUX1* function activated via a binary control input configured to this function
  - Start AUX2: start of *AUX2* function activated via a binary control input configured to this function
  - tI>: time-delay of the first o/c stage
  - tI>>: time-delay of the second o/c stage
  - tI>>>: time-delay of the third o/c stage
  - tIN>: time-delay of the first e/f stage
  - tIN>>: time-delay of the second e/f stage
  - tIasym>: time-delay of the asymmetry protection element
  - CB Fail: the time elapsed of the CB Fail function
  - CB Ext.: triggered binary input configured to CB Ext. function
  - tAUX1: time-delay of AUX1 function activated via binary input configured to this function
  - tAUX2: time-delay of AUX2 function activated via binary input configured to this function
  - tCBF: time-delay of the Circuit Breaker Failure protection element
  - CB not healthy: binary input configured to the CB not healthy . function, which trigger is delayed beyond the settable *tCB not healthy* time delay (*GLOBAL SETTINGS*/*CIRCUIT BREAKER*)
  - Setting Group 1: P115 works on Setting Group 1 (for Setting Group 1 column)
  - Setting Group 2: P115 works on Setting Group 2 (for Setting Group 2 column)

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- Start Phase A – Indicates that the fault is in phase A (starting of o/c element)
- Start Phase B – Indicates that the fault is in phase B (starting of o/c element)
- Start Phase C – Indicates that the fault is in phase C (starting of o/c element)
- Start Earth – Indicates the earth fault (starting of e/f element)

After establishing the connection between PC and P115 via the USB port, the green *Healthy* LED should be lit permanently (it means that the P115 is powered), even if P115 is not connected to auxiliary voltage supply.

The remaining LEDs can be checked via the "LEDs Reset" function. This function can be set to L1 or L2 input.

Ensuring that the correct opto input L1 (terminals 13 and 15) or L2 (terminals 14 and 15) nominal voltage is applied and correct polarity, connect the field supply voltage to the appropriate terminals for the input being tested.

All red LEDs should be lit within 1 s.

Default LEDs setting (both Setting Groups):

- LED3: not configured
- LED4: not configured
- LED5: not configured
- LED6: not configured
- LED7: not configured
- LED8: not configured

4.2.2 Binary inputs

This test checks that all the binary inputs on the relay are functioning correctly.

The binary inputs should be energized one at a time, see external connection diagrams (P115/EN IN) for terminal numbers.

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The P115 has a display so it is possible to see the state of the binary inputs, by going to the*COMMISSIONING*/*Opto I/P Status* window in the menu, or by using MiCOM S1/S&R Modbus/ Measurement Viewer software. Refer to the MiCOM S1 software user manual for details.

If it is not possible to use Measuring Viewer software, it is necessary to check the binary inputs by means of a functional test of the entire configuration.

Ensuring that the correct opto input nominal voltage is applied and correct polarity, connect the field supply voltage to the appropriate terminals for the input being tested

NOTE: The binary inputs may be energized from an external dc auxiliary supply (e.g. the substation battery) in some installations. Check that this is not the case before connecting the field voltage, otherwise damage to the relay may result. If an external 24/27 V, 30/34 V, 48/54 V, 110/125 V, 220/250 V supply is being used it will be directly connected to the relays optically isolated inputs . If an external supply is being used then it must be energized for this test but only if it has been confirmed that it is suitably rated with less than 12% ac ripple.

Default factory settings:

- L1 binary input: not configured
- L2 binary input: not configured

Reverse Input Logic indicates the low state of the Binary Input triggered by a programmable function.

4.2.3 Output relays

To check output contacts it is necessary to carry out a functional test of the entire configuration.

NOTE: It should be ensured that thermal ratings of anything connected to the output relays during the contact test procedure are not exceeded by the associated output relay being operated for too long. It is therefore advised that the time between application and removal of the contact test is kept to the minimum.

Default factory settings:

- RL1 output: *Any Trip*, no latching, no *Reverse output logic*
- RL2 output: not configured
- RL3 output: not configured
- RL4 output: not configured

Reverse Output Logic means that after powering the P115, n/o contacts are closed. Output triggering via a programmable function opens the contacts (rest position).

4.2.4 Rear communications port

This test should only be performed where the relay is to be accessed from a remote location and will vary depending on the communications standard adopted.

It is not the intention of the test to verify the operation of the complete system from the relay to the remote location, just the relay's rear communications port and any protocol converter necessary.

4.2.4.1 IEC60870-5-103 (VDEW) communications

IEC60870-5-103/VDEW communication systems are designed to have a local Master Station and this should be used to verify that the relay's EIA(RS)485 port, is working.

The relay address and baud rate settings for EIA(RS)485 can be set by using local communication via the USB port (setting software) or via the relay's front panel.

Default Factory Setting:

- Baud Rate: 19.2bps
- Parity: No parity
- Stop Bits: one stop bit
- Data Bits: 8 (fixed)

After that ensure that the relay address and baud rate settings in the application software are set the same as was set via USB port.

Check that, using the Master Station, communications with the relay can be established.

4.2.4.2 MODBUS communications

Connect a portable PC running the appropriate MODBUS Master Station software to the relay's first rear EIA(RS)485 port via an EIA(RS)485 to EIA(RS)232 interface converter. The terminal numbers for the relays EIA(RS)485 port are up to 31.

The relay address, Parity and Baud Rate settings for EIA(RS)485 are set by using local communication via USB port (MiCOM S1 software).

Default Factory Setting:

- Baud Rate: 19.2bps
- Parity: None
- Stop Bits: one stop bit
- Data Bits: 8 (no settable)

Ensure that the relay's address and baud rate settings in the application software are the same as those set via USB port.

Check that communications with the relay can be established.

4.2.5 USB communications port

The USB port is used for local communications between a PC and the P115.

The USB port integrates electronic boards only to allow communications with the P115 via the HMI/RS485/USB interfaces. Input (binary and current) and Output boards are not supplied.

For local communications, the MiCOM S1 setting software is used.

USB parameters (not settable in the P115):

- Protocol: Modbus RTU
- Address: 1
- Baud Rate: 115.2kbits/s
- Data Bits: 8
- Stop bit: 1
- Parity: None

4.2.6 Current inputs

This test verifies that the accuracy of current measurement is within the acceptable tolerances.

The P115 measures the RMS value

Apply current equal to the line current transformer secondary winding rating to each current transformer input of the corresponding rating, in turn, see Table 1 or external connection diagram (P115/EN IN) for appropriate terminal numbers, checking its magnitude using a multimeter/test set readout. The corresponding reading can then be checked in the MEASUREMENT column of the menu or via MiCOM S1/S&R Modbus/Measurement Viewer connected to P115 via USB port. Refer to the PC software user manual for details.

If the use of MiCOM S1 is not possible, it is necessary to test the protection stages to measure the accuracy of analogue inputs.

Measuring accuracy of the relay:

Reference Conditions:

Sinusoidal signals with nominal frequency fn total harmonic distortion ≤2 %, ambient temperature 20 °C and nominal auxiliary voltage Vx.

Deviation relative to the relevant nominal values under reference conditions

Operating Data

For current up to 3 In (Ien):

Phase and earth current: ±3%

Asymmetry current: ±5%

Fault Data

Phase and earth current:

For current ≤ 3 In (Ien): ±5%

For current > 3 In (Ien): ±5% of measured current value

However, an additional allowance must be made for the accuracy of the test equipment being used.

5. SETTING CHECKS

The setting checks ensure that all of the application-specific relay settings (i.e. the relay's functions), for the particular installation, have been correctly applied to the relay.

NOTE: The trip circuit should remain isolated during these checks to prevent accidental operation of the associated circuit breaker.

5.1 Apply application-specific settings

There are two methods of applying the settings to the relay:

Downloading them from a pre-prepared setting file to the relay using a portable PC running the MiCOM S1 support software. Communication between the PC and the P115 is done via the relay's USB front port, located at the bottom of front panel, or rear communications port. This method is preferred for transferring function settings as it is much faster and there is less margin for error.

If a setting file has been created for the particular application and is available on an external memory disk, this will further reduce the commissioning time.

Enter them manually via the relay's operator interface.

Application notes for the setting values are given in Application Notes chapter P115/EN AP of this manual.

5.2 Demonstrate correct relay operation

The above tests have already demonstrated that the relay is within calibration, thus the purpose of these tests is as follows:

- To determine that the primary protection functions of the relay, overcurrent, earth-fault etc. can trip according to the correct application settings.
- To verify the correct assignment of the CB trip outputs and of the flag indicator output, by monitoring the response to a selection of fault injections.

5.2.1 Overcurrent protection testing

This test, performed on stage 1 of the overcurrent protection function, demonstrates that the relay is operating correctly at the application-specific settings.

5.2.1.1 Connection and preliminaries

The testing current is fed via terminals: 1-2, 3-4, 5-6,7-8-9 connected to CTs. The type of connection is shown in Figure 1. The external connection diagram is also available on the front panel of P115.

Ensure that I> is configured to RL1 output.

NOTE: The Low Energy Trip output and the Flag Indicator outputs are activated by any protection elements set to trip.

Disconnect auxiliary voltage supply from P115 terminals 11 and 12.

Connect the trip output or flag indicator output so that its operation will trip the test set and stop the timer.

NOTE: During tripping, the trip and flag indicator outputs output energy on terminals is::

- trip coil output: 0.1 Ws 24 Vdc or 0.02 Ws 12 V (ordering option)
- flag indicator output: 0.01 Ws 24 Vdc

The timer should be compatible with the above outputs.

Connect the current output of the test set to the "A" phase of the relay current transformer input (terminals 1 and 2).

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Ensure that the timer starts when the current is applied to the relay.

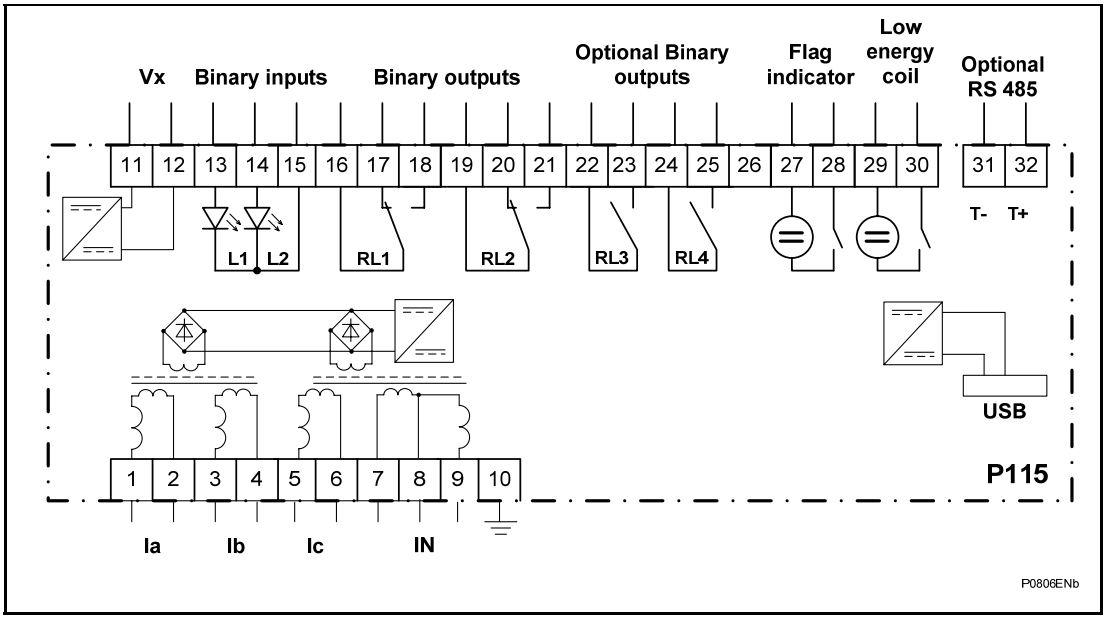

Figure 1: P115 external connection diagram

5.2.1.2 Perform the test

Ensure that the timer is reset.

Apply to the relay a current of twice the setting for I> to the relay (refer to chapter P115/EN ST of this manual) and make a note of the time displayed when the **chronometer** stops.

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WARNING: NEVER OPEN CIRCUIT THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER SINCE THE HIGH VOLTAGE PRODUCED MAY BE LETHAL AND COULD DAMAGE INSULATION.

5.2.1.3 Check the operating time

Check that the operating time recorded by the timer is within the range shown in Table 2.

NOTES: Except for the definite time characteristic, the operating times given in Table 2 are for a time multiplier or time dial setting of 1. Therefore, to obtain the operating time at other time multiplier or time dial settings, the time given in Table 2 must be multiplied by the setting for IDMT characteristics.

In addition, for definite time and inverse characteristics there is an additional delay of up to 0.03 seconds that may need to be added to the relay's acceptable range of operating times.

If the P115 is not connected to an auxiliary voltage supply (Vx) it is necessary to add an additional start-up time delay. The value of this delay depends on the ratio: value current/0.2In. Refer to the Application chapter of this manual (P115/EN AP) or the Technical Data chapter of this manual (P115/EN TD)

For all characteristics, allowance must be made for the accuracy of the test equipment being used.

Characteristic	Operating Time at Twice Current Setting and Time Multiplier/Time Dial Setting of 1.0	
	Nominal (Seconds)	Range (Seconds)
DT	tI> Time Delay Setting	Setting ±5%
IEC S Inverse	10.03	9.28 – 11.78
IEC V Inverse	13.50	12.49 – 14.51
IEC E Inverse	26.67	24.67 – 29.67
UK LT Inverse	120.00	111.00 – 129.00
UK ST Inverse	1.78	1.65 – 1.91
IEEE M Inverse	3.8	3.52 – 4.08
IEEE V Inverse	7.03	6.51 – 7.55
IEEE E Inverse	9.52	8.81 – 10.23
US Inverse	2.16	2.00 – 2.32
US ST Inverse	12.12	11.22 – 13.02
RI Inverse	4.52	4.19 – 4.86

Table 2: Characteristic operating times for I>

Reconfigure to test a B phase fault. Repeat the test in section 5.2.1.2, this time ensuring that the breaker trip output relative to B phase operation, trips correctly. Record the phase B trip time. Repeat for C phase fault.

5.2.1.4 Check the outputs

5.2.1.4.1 CB coil output

Ensure that the CB coil is connected to terminals 29 (+) and 30 (–).

Ensure that I> stage is configured to trip (refer to chapter P115/EN ST of this manual)

Close the CB.

Connect a multimeter with recording of maximum dc voltage value to terminals 29 and 30.

Apply a current of twice the setting for I>.. The CB will open when the tI> time delay elapses.

Record the maximum voltage value measured by the multimeter. The value should be greater than:

(i) 24 Vdc to 26.4 Vdc: for ordering option 24 Vdc 0.1 Ws

(ii) 12 Vdc to 13.2 Vdc: for ordering option 12 Vdc 0.02 Ws

P115 should trip CB.

5.2.1.4.2 Flag indicator output

Ensure that the Flag indicator is connected to terminals 27 (+) and 28 (–).

Reset the Flag indicator.

Connect a multimeter with recording of maximum dc voltage value to terminals 27 and 28.

Apply a current of twice the setting for I> . The Flag indicator will be triggered when the tI> time delay elapses.

Record the maximum voltage value measured by the multimeter.

The value should be: 24 Vdc to 26.4 Vdc.

Flag indicator should be tripped.

6. COMMISSIONING TEST RECORD

Date: _____ Engineer: _____

Station: Circuit: _____

System Frequency: _____ Hz

P115 Front Plate Information

Overcurrent protection relay	**MiCOM P115**
Model number	
Serial number	

Test Equipment Used

This section should be completed to allow future identification of protective devices that have been commissioned using equipment, that is later found to be defective or incompatible, but may not be detected during the commissioning procedure.

Injection test set	Model: Serial No:	
Insulation tester	Model: Serial No:	
Setting software:	Type: Version:	

*Delete as appropriate

Have all relevant safety instructions been followed? Yes* ☐ No* ☐

1.	**Product Checks**	
1.1	**With the relay de-energized**	
1.1.1	Visual inspection	
1.1.1.1	Relay damaged?	Yes* ☐ No* ☐
1.1.1.2	Rating information correct for installation?	Yes* ☐ No* ☐
1.1.1.3	Case earth installed?	Yes* ☐ No* ☐
1.1.2	Insulation resistance >100MΩ at 500V dc	Yes* ☐ No* ☐ Not Tested* ☐
1.1.3	External wiring	
1.1.3.1	Wiring checked against diagram?	Yes* ☐ No* ☐
1.1.4	Measured auxiliary voltage supply	_____ V ac*

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1.2	**With the relay energized**	
1.2.1	Light emitting diodes	
1.2.1.1	Connect auxiliary voltage supply to terminals 11 and 12. Green *Healthy* LED working?	Yes* ☐ No* ☐
1.2.1.2	Supply P115 with current above self-powering level (0.2In). Green *Healthy* LED working?	Yes* ☐ No* ☐
1.2.1.3	Establish connection between PC and P115 via USB port. Green *Healthy* LED working?	Yes* ☐ No* ☐
1.2.1.4	Reset LEDs by pressing the C key on the P115's front panel. Red "I>" LED flashing rapidly?	Yes* ☐ No* ☐
1.2.2	Inputs	
1.2.2.1	Auxiliary voltage for binary control inputs: Value measured (see: *COMMISSIONING/Opto I/P Status* window of menu)	_____ V dc
1.2.2.2	L1 binary input working?	Yes* ☐ No* ☐
1.2.2.3	L2 binary input working?	Yes* ☐ No* ☐
1.2.3	Outputs (for tests, *COMMISSIONING/ Test outputs* cell can be used)	
1.2.3.1	Output Relays	
1.2.3.1.1	Relay 1 working?	Yes* ☐ No* ☐
1.2.3.1.2	Relay 2 working?	Yes* ☐ No* ☐
1.2.3.1.3	Relay 3 working?	Yes* ☐ No* ☐ N/A* ☐
1.2.3.1.4	Relay 4 working?	Yes* ☐ No* ☐ N/A* ☐
1.2.3.2	Maximum voltage value measured on Low Energy Tripping Coil output (29 and 30) during trip signal (note: 50ms pulse signal)	_____ V dc
1.2.3.3	Maximum voltage value measured on Flag Indicator output (27 and 28) during trip signal (note: 50ms pulse signal)	_____ V dc
1.2.3.4	Close CB, after which apply current above setting value. CB has opened?	Yes* ☐ No* ☐
1.2.4	Communications between PC and MiCOM S1 setting software established?	Yes* ☐ No* ☐
2.	Setting Checks	
2.1	Protection function timing tested?	Yes* ☐ No* ☐
	Applied current	_____ A
	Expected operating time	_____ s
	Measured operating time	_____ s

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3.	Final Checks	
3.1	All test equipment, leads, shorts and test blocks removed safely?	Yes* ☐ No* ☐
3.2	Disturbed customer wiring re-checked?	Yes* ☐ No* ☐ N/A* ☐
3.3	All commissioning tests disabled?	Yes* ☐ No* ☐
3.4	Fault records reset (via S1 software)?	Yes* ☐ No* ☐

COMMENTS #
(# Optional, for site observations or utility-specific notes).

Commissioning Engineer

Customer Witness

Date:

Date:

7. SETTING RECORD

Date:		Engineer:	
Station:		Circuit:	
		System Frequency:	Hz
		CT Ratio (tap in use):	/ A

Front Plate Information

Overcurrent protection relay	**MiCOM P115**
Model number	
Serial number	
Rated phase current In	
Rated e/f current Ien	

*Delete as appropriate

Column	**Identification of Relay**	
OP PARAMETERS	Firmware version	
	Hardware version	

Column	**Global Setting Data**	
GLOBAL SETTINGS/ CT RATIO	Line CT primary	A
	E/Gnd CT primary	A
	IN connection	0:terminals:7-9* ☐ 1:terminals 8-9* ☐
GLOBAL SETTINGS/ CIRCUIT BREAKER	tOpen pulse min	s
	tClose Pulse	s
	tP pulse.	s
	t CB not Healthy	s
GLOBAL SETTINGS/ COMMUNICATION	Relay Address RS485	
	Baud Rate RS485	
	Parity RS485	
	StopBits RS485	
	Protocol RS485	Modbus RTU* ☐ IEC103* ☐

Column	Global Setting Data	
GLOBAL SETTINGS/ LOC	Language	0: English* ☐ 1: German* ☐ 2: Polish* ☐ 3: French* ☐ 4: Spanish* ☐ 5: Regional* ☐
	Default Display	0: Meas. In * ☐ 1: Meas. A* ☐ 2: Control* ☐
	LEDs Reset by Start	0:No* ☐ 1:Yes* ☐
	Alarm Display	0: Self-Reset * ☐ 1:Manual Reset* ☐

Column	Setting Group	
GLOBAL SETTINGS/ SETTING GROUP SELECT	Active Setting Group	Group 1* ☐ Group 2* ☐
	T Change Setting G1→G2	s

OVERCURRENT G1		
SETTING GROUP 1/ PROTECTION G1/PHASE O/C G1		Settings
1	I> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	I> Threshold	In
3	Delay Type I>	
4	tI>/TMS/TD	s
5	Reset Delay Type I>	
6	DMT tReset I>	s
7	I>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
8	I>> Threshold	In
9	Delay Type I>>	
10	tI>>/TMS/TD	s
11	Reset Delay Type I>>	
12	DMT tReset I>>	s
13	I>>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
14	I>>> Threshold	In
15	tI>>>	s

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EARTH FAULT (Measured) G1		
SETTING GROUP 1/ PROTECTION G1 / E/GND FAULT G1		Settings
1	IN> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	IN> Threshold	Ien
3	Delay Type IN>	
4	tIN>/TMS/TD	s
5	Reset Delay Type IN>	
6	DMT tReset IN>	s
7	IN>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
8	IN>> Threshold	
9	tIN>>	s

ASYMMETRY G1		
SETTING GROUP 1/ PROTECTION G1 / ASYMMETRY G1		Settings
1	Iasym> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	Iasym> Threshold	In
3	tIasym>	s

[50BF] CB Fail G1		
SETTING GROUP 1/ PROTECTION G1 / ASYMMETRY G1		Settings
1	CB Fail ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	CB Fail Time tBF	s
3	I< Threshold	In
4	IN< Threshold	Ien

AUX TIMERS G1		
SETTING GROUP 1/ PROTECTION G1 / AUX TIMERS G1		Group 1 Settings
1	AUX1 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	tAUX1	s
3	AUX2 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
4	tAUX2	s

OUTPUT RELAYS CONFIGURATION G1							
SETTING GROUP 1/ OUTPUT RELAY CONFIGURATION G1		RL1	RL2	RL3	RL4	FI	TC
1	Latched outputs						
2	Reverse outp. logic						
3	Protection Trip						
4	Any Trip (pulse)						
5	Alarm						
6	start I>						
7	start I>>						
8	start I>>>						
9	start IN>						
10	start IN>>						
11	start Iasym>						
12	start AUX1						
13	start AUX2						
14	tI>						
15	tI>>						
16	tI>>>						
17	tIN>						
18	tIN>>						
19	tIasym>						
20	tCBF						
21	CBF ext.						
22	tAUX1						
23	tAUX2						
24	Trip pulse tP						
25	Close CB						

OUTPUT RELAYS CONFIGURATION G1							
26	Trip CB						
27	CB not Healthy						
28	Hardware Warning						
29	Start Phase A						
30	Start Phase B						
31	Start Phase C						
32	Start Earth						

INPUTS CONFIGURATION G1			
SETTING GROUP 1/ INPUT CONFIGURATION G1		Input L1	Input L2
1	Reverse Input Logic		
2	Blocked outputs		
3	Reset Latched LEDs		
4	Reset Latched Outputs		
5	Blocking I>		
6	Blocking I>>		
7	Blocking I>>		
8	Blocking IN>		
9	Blocking IN>>		
10	Blocking Iasym>		
11	Blocking AUX1		
12	Blocking AUX2		
13	Blocking CBF		
14	AUX1		
15	AUX2		
16	CBF ext.		
17	CB Status 52A		
18	CB Status 52B		
19	CB not Healthy		
20	Setting Group 2		

LEDs CONFIGURATION G1							
SETTING GROUP 1/ LEDs CONFIGURATION G1		LED3	LED4	LED5	LED6	LED7	LED8
1	Latched LEDs						
2	Protection Trip						
3	Alarm						
4	Start I>						
5	Start I>>						
6	Start I>>>						
7	Start IN>						
8	Start IN>>						
9	Start Iasym>						
10	Start AUX1						
11	Start AUX2						
12	tI>						
13	tI>>						
14	tI>>>						
15	tIN>						
16	tIN>>						
17	tIasym>						
18	CB Fail						
19	CB ext.						
20	tAUX1						
21	tAUX2						
22	CB not Healthy						
23	Setting Group 1						
24	Start Phase A						
25	Start Phase B						
26	Start Phase C						
27	Start Earth						

OVERCURRENT G2		
SETTING GROUP 2 PROTECTION G2PHASE O/C G2		Settings
1	I> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	I> Threshold	In
3	Delay Type I>	
4	tI>/TMS/TD	s
5	Reset Delay Type I>	
6	DMT tReset I>	s
7	I>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
8	I>> Threshold	In
9	Delay Type I>>	
10	tI>>/TMS/TD	s
11	Reset Delay Type I>>	
12	DMT tReset I>>	s
13	I>>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
14	I>>> Threshold	In
15	tI>>>	s

EARTH FAULT (Measured) G2		
SETTING GROUP 2 PROTECTION G2/ E/GND FAULT G2		Settings
1	IN> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	IN> Threshold	Ien
3	Delay Type IN>	
4	tIN>/TMS/TD	s
5	Reset Delay Type IN>	
6	DMT tReset IN>	s
7	IN>> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
8	IN>> Threshold	
9	tIN>>	s

ASYMMETRY G2		
SETTING GROUP 2 PROTECTION G2/ ASYMMETRY G2		Settings
1	Iasym> ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	Iasym> Threshold	In
3	tIasym>	s

[50BF] CB Fail G2		
SETTING GROUP 2/ PROTECTION G2 / ASYMMETRY G2		Settings
1	CB Fail ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	CB Fail Time tBF	s
3	I< Threshold	In
4	IN< Threshold	Ien

CM

AUX TIMERS G2		
SETTING GROUP 2/ PROTECTION G2 / AUX TIMERS G2		Group 1 Settings
1	AUX1 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
2	tAUX1	s
3	AUX2 ?	0: Disabled* ☐ 1: Trip* ☐ 2: Alarm* ☐
4	tAUX2	s

OUTPUT RELAYS CONFIGURATION G2							
SETTING GROUP 2/ OUTPUT RELAY CONFIGURATION G2		RL1	RL2	RL3	RL4	FI	TC
1	Latched outputs						
2	Reverse outp. logic						
3	Protection Trip						
4	Any Trip (pulse)						
5	Alarm						
6	start I>						
7	start I>>						
8	start I>>>						
9	start IN>						
10	start IN>>						
11	start Iasym>						
12	start AUX1						
13	start AUX2						
14	tI>						
15	tI>>						
16	tI>>>						
17	tIN>						
18	tIN>>						
19	tIasym>						
20	tCBF						
21	CBF ext.						
22	tAUX1						
23	tAUX2						
24	Trip pulse tP						
25	Close CB						

OUTPUT RELAYS CONFIGURATION G2							
26	Trip CB						
27	CB not Healthy						
28	Hardware Warning						
29	Start Phase A						
30	Start Phase B						
31	Start Phase C						
32	Start Earth						

INPUTS CONFIGURATION G2			
SETTING GROUP 2/ INPUT CONFIGURATION G2		Input L1	Input L2
1	Reverse Input Logic		
2	Blocked outputs		
3	Reset Latched LEDs		
4	Reset Latched Outputs		
5	Blocking I>		
6	Blocking I>>		
7	Blocking I>>		
8	Blocking IN>		
9	Blocking IN>>		
10	Blocking Iasym>		
11	Blocking AUX1		
12	Blocking AUX2		
13	Blocking CBF		
14	AUX1		
15	AUX2		
16	CBF ext.		
17	CB Status 52A		
18	CB Status 52B		
19	CB not Healthy		
20	Setting Group 2		

LEDs CONFIGURATION G2							
SETTING GROUP 2/ LEDs CONFIGURATION G2		LED3	LED4	LED5	LED6	LED7	LED8
1	Latched LEDs						
2	Protection Trip						
3	Alarm						
4	Start I>						
5	Start I>>						
6	Start I>>>						
7	Start IN>						
8	Start IN>>						
9	Start Iasym>						
10	Start AUX1						
11	Start AUX2						
12	tI>						
13	tI>>						
14	tI>>>						
15	tIN>						
16	tIN>>						
17	tIasym>						
18	CB Fail						
19	CB ext.						
20	tAUX1						
21	tAUX2						
22	CB not Healthy						
23	Setting Group 2						
24	Start Phase A						
25	Start Phase B						
26	Start Phase C						
27	Start Earth						

Commissioning Engineer

Customer Witness

Date:

Date:

CM

MAINTENANCE

MT

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

MT

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MT

1. MAINTENANCE

1.1 Maintenance period

It is recommended that products supplied by Schneider Electric receive periodic monitoring after installation. In view of the critical nature of protective relays and their infrequent operation, it is desirable to confirm that they are operating correctly, at regular intervals.

Schneider Electric protective relays are designed for a life in excess of 20 years.

MiCOM relays are self-monitoring and so require less maintenance than earlier designs of relay. Most problems will set off an alarm so that remedial action can be taken. However, some periodic tests should be carried out to ensure that the relay is functioning correctly and that the external wiring is intact.

1.2 Maintenance checks

Although some functionality checks can be performed from a remote location by utilizing the communications ability of the relays, these are predominantly restricted to checking that the relay is measuring the applied currents accurately. Therefore it is recommended that maintenance checks are performed locally (i.e. at the substation itself).

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide SFTY/4L M/E11 or later issue, OR the safety and technical data section of the technical manual and also the ratings on the equipment rating label.

For safety reasons, no work must be carried out on the P115 until all power sources to the unit have been disconnected.

1.2.1 Binary Inputs

Binary inputs can be checked to ensure that the relay responds to its energization by repeating the commissioning test detailed in section 4.2.2 of the Commissioning chapter (P115/EN CM).

MT

1.2.2 Outputs

The output relays can be checked to ensure that they operate by repeating the commissioning test detailed in section 5.2.1.4 of the Commissioning chapter (P115/EN CM).

1.2.3 Measurement accuracy

If the power system is energized, the values measured by the relay can be compared with known system values to check that they are in the approximate expected range.. If they are, then the analogue/digital conversion and calculations are being performed correctly by the relay. Suitable test methods can be found in sections 4.2.6 of the Commissioning chapter (P115/EN CM).

Alternatively, the values measured by the relay can be checked against known values injected into the relay via the test block, if fitted, or injected directly into the relay terminals. These tests will prove the calibration accuracy is being maintained.

1.3 Method of repair

It is recommended that the P115 relay is returned to an Schneider Electric service centre for repair.

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide SFTY/4L M/E11 or later issue, OR the safety and technical data section of the technical manual and also the ratings on the equipment rating label.

For safety reasons, no work must be carried out on the P115 until all power sources to the unit have been disconnected.

1.4 Cleaning

Before cleaning the equipment ensure that all current transformers and voltage input connections are isolated to prevent any possibility of an electric shock whilst cleaning.

The equipment may be cleaned using a lint-free cloth moistened with clean water. The use of detergents, solvents or abrasive cleaners is not recommended as they may damage the relay's surface and leave a conductive residue.

TROUBLESHOOTING

TS

Date: 20th February 2009

Hardware Suffix: A

Software Version: 1D

Connection Diagrams: 10P11504

TS

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TS

1. INTRODUCTION

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide SFTY/4L M/E11 or later issue, OR the safety and technical data section of the technical manual and also the ratings on the equipment rating label.

For safety reasons, no work must be carried out on the P115 until all power sources to the unit have been disconnected.

The purpose of this section of the service manual is to allow an error condition on the relay to be identified so that appropriate corrective action can be taken.

In cases where a faulty relay is being returned to the manufacturer or one of their approved service centers, a completed copy of the Repair/Modification Return Authorization Form located at the end of this section should be included.

2. INITIAL PROBLEM IDENTIFICATION

Consult the table below to find the description that best matches the problem experienced, then consult the section referenced to perform a more detailed analysis of the problem.

Symptom	Refer To
Relay fails to power up	Section 3
Maloperation of the relay during testing	Section 4

Table 1: Problem identification

3. POWER UP ERRORS

P115 can be powered up in the following ways:

- USB connection to PC .
- Auxiliary voltage (Vx)
- Current inputs

If the relay does not appear to power up then the following procedure can be used to determine whether the fault is in the external wiring or in the power supply module of the relay.

Test	Check	Action
1	1. Connect the P115 to a PC via the USB port. 2. Disconnect the PC from the P115 USB port.	(i) If the green “Healthy” LED and display are lit then proceed to test 2. (ii) If the green “Healthy” LED and display are not lit then proceed to test 2.
2	1. Apply a Vx auxiliary voltage on terminals 11-12 (check the level on the P115 nominal label) 2. Check whether the green “Healthy” LED on the P115 front panel is lit. 3. Disconnect the ac auxiliary voltage from terminals 11-12.	(i) If the green “Healthy” LED and display are lit then proceed to test 3. (ii) If the green “Healthy” LED and display are not lit then send the relay back to Schneider Electric repair centre.
3	1. Connect the Current Test equipment to the current input terminals: 1-2. 2. Apply 0.2 In current 3. Disconnect the Current Test equipment from current input terminals: 1-2. 4. Repeat procedure for terminals: 3-4, 5-6 and 7-9 (0.2 Ien)	(i) If the green “Healthy” LED and display are not lit in all four tests, it means that P115 is damaged. Send the relay back to Schneider Electric repair centre. (ii) If the green “Healthy” LED and display are lit in test 1 and 2 but not lit in test 3, check the current circuit wiring. If all connections are OK, send the relay and CTs back to Schneider Electric repair centre. (iii) If the green “Healthy” LED and display are lit in test 1 and 3 but not lit in test 2, check the auxiliary voltage level on terminals 11-12 and connections in that circuit. If all connections are OK and the voltage level is in the required range (refer to Technical Data chapter of this manual), send the relay back to Schneider Electric repair centre.

Table 2: Failure of relay to power up

4. MALOPERATION OF THE RELAY DURING TESTING

4.1 Failure of binary inputs

The binary inputs are configured in the SETTING GROUP1 (2)/INPUTS CONFIGURATION column for each setting group. If an input does not appear to be recognized by the relay scheme logic the COMMISSIONING/Opto I/P Status menu option can be used to verify whether the problem is in the binary input itself or the mapping of its signal to the scheme logic functions. If the binary input appears to be read correctly then it is necessary to examine its configuration.

Ensure the voltage rating for the opto inputs has been configured correctly with applied voltage. If the binary input state is not read correctly by the relay the applied signal should be tested. Verify the connections to the binary input using the correct wiring diagram. Next, using a voltmeter verify that 80% opto setting voltage is present on the terminals of the binary input in the energized state. If the signal is being correctly applied to the relay then the failure may be on the input card itself.

NOTE:
1. If the P115 is supplied by the USB port only, only part of the P115's electronics (necessary to the communication facility) is supplied. From this reason, the inputs' status is in high state (not dependent on the voltage on the terminals). Any action pertaining to binary inputs is blocked.
2. The *COMMISSIONING /Opto I/P Status* cell displays the logical state of the inputs (not the presence of voltage on their terminals). For example: if Vx is applied (high state) on the terminals of a binary input and the Reverse Input Logic is set (function active in binary input low state), the *COMMISSIONING /Opto I/P Status* cell displays the logical state of the input as low (logical state after processing by the Reverse Input Logic function)

4.2 Failure of output contacts

An apparent failure of the relay output contacts may be caused by the relay configuration; the following tests should be performed to identify the real cause of the failure. Output testing can be performed using the COMMISSIONING/Test outputs cell. When the command is executed the set outputs (COMMISSIONING/Test Pattern) will be energized and will remain so for the duration of the TOpen pulse (GLOBAL SETTINGS/ CIRCUIT BREAKER/ tOpen pulse min).

Test	Check	Action
1	Is the Out of Service LED illuminated?	Illumination of this LED may indicate that the relay is in test mode or that the protection has been disabled due to a hardware verify error (see Table 2).
2	Examine the *Test outputs* in the Commissioning section of the menu.	If the relevant bits of the contact status are operated then proceed to test 4, if not proceed to test 3.
3	Verify by examination of the fault record whether the protection element is operating correctly.	If the protection element does not operate verify whether the test is being correctly applied. If the protection element operates then it is necessary to check the configuration, to ensure that the configuration of the protection element to the contacts is correct.
4	Using the procedure described in the Commissioning chapter (P115/EN CM) energize every output (note the correct external connection diagram should be consulted). A continuity tester can be connected at the rear of the relay for this purpose.	If the output relay operates then the problem must be situated in the external wiring to the relay. If the output relay does not operate this could indicate a failure of the output relay contacts (note that the self-tests verify that the relay coil is being energized). Ensure that the closed resistance is not too high for the continuity tester to detect.

Table 3: Failure of output contacts

5. REPAIR AND MODIFICATION PROCEDURE

Please follow these 5 steps to return an Automation product to us:

1. Get the Repair and Modification Authorization Form (RMA)

Find a copy of the RMA form at the end of this section.

- To obtain an electronic version of the RMA form for e-mailing, please contact your local Schneider Electric service.

2. Fill

Fill in only the white part of the form.

Please ensure that all fields marked **(M)** are completed such as:

- Equipment model
- Model No. and Serial No.
- Description of failure or modification required (please be specific)
- Value for customs (in case the product requires export)
- Delivery and invoice addresses
- Contact details

3. Send RMA form to your local Schneider Electric contact

4. Receive from local service contact, the information required to ship the product

Your local service contact will provide you with all the information:

- Pricing details
- RMA n°
- Repair centre address

If required, an acceptance of the quote must be delivered before going to next stage.

5. Send the product to the repair centre

- Address the shipment to the repair centre specified by your local contact
- Ensure all items are protected by appropriate packaging: anti-static bag and foam protection
- Ensure a copy of the import invoice is attached with the unit being returned
- Ensure a copy of the RMA form is attached with the unit being returned
- E-mail or fax a copy of the import invoice and airway bill document to your local contact.

SYMBOLS AND GLOSSARY

SG

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

SG

Logic Symbols

Symbols	Explanation
>	**Greater than:** Used to indicate an “over” threshold, such as overcurrent (current overload).
C/O	**A changeover contact having normally closed and normally open connections:** Often called a “form C” contact.
CB	Circuit breaker.
CT	Current transformer.
Dly	Time delay.
DT	**Abbreviation of “Definite Time”:** An element which always responds with the same constant time delay on operation.
E/F	**Earth fault:** Directly equivalent to ground fault.
FLC	**Full load current:** The nominal rated current for the circuit.
Flt.	**Abbreviation of “Fault”:** Typically used to indicate faulted phase selection.
FN	Function.
Gnd.	**Abbreviation of “Ground”:** Used in distance settings to identify settings that relate to ground (earth) faults.
I	Current.
I>	**Second stage of phase overcurrent protection:** Could be labeled 51-2 in ANSI terminology.
I>>	**Third stage of phase overcurrent protection:** Could be labeled 51-3 in ANSI terminology.
IN>	**Earth Fault current:** Equals the neutral current measured at the analog input.
IA	**Phase A current:** Might be phase L1, red phase.. or other, in customer terminology.
IB	**Phase B current:** Might be phase L2, yellow phase.. or other, in customer terminology.
IC	**Phase C current:** Might be phase L3, blue phase.. or other, in customer terminology.
IDMT	**Inverse definite minimum time:** A characteristic whose trip time depends on the measured input (e.g. current) according to an inverse-time curve.
In	**The rated nominal current of the CT:** Software selectable as 1 amp or 5 amp to match the line CT input.
Ien	**The rated nominal current of the E/F CT:** Software selectable as 1 amp or 5 amp to match the line E/F CT input.
IN	**Neutral current, or residual current:** This results from an external summation of the three measured phase currents.

Symbols	Explanation
Inst.	**An element with "instantaneous" operation:** i.e. having no deliberate time delay.
I/O	**Abbreviation of "Inputs and Outputs":** Used in connection with the number of opto-coupled inputs and output contacts within the relay.
I/P	Abbreviation of "Input".
LD	**Abbreviation of "Level Detector":** An element responding to a current or voltage below its set threshold.
LED	**Light emitting diode:** Red or green indicator on the relay front-panel.
N	**Indication of "Neutral" involvement in a fault:** i.e. a ground (earth) fault.
N/A	Not applicable.
N/C	**A normally closed or "break" contact:** Often called a "form B" contact.
N/O	**A normally open or "make" contact:** Often called a "form A" contact.
O/P	Abbreviation of "output".
Opto	**An opto-coupled logic input:** Alternative terminology: binary input.
PCB	Printed circuit board.
Ph	**Abbreviation of "Phase":** Used in distance settings to identify settings that relate to phase-phase faults.
R	A resistance.
Rx	**Abbreviation of "Receive":** Typically used to indicate a communication receive line/pin.
T	A time delay.
TE	**A standard for measuring the width of a relay case:** One inch = 5TE units.
TMS	The time multiplier setting applied to IEC or UK inverse-time curves
TD	The time multiplier setting applied to IEEE or US inverse-time curves
Tx	**Abbreviation of "Transmit":** Typically used to indicate a communication transmit line/pin.

INSTALLATION

IN

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
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IN

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IN

1. RECEIPT OF RELAYS

Upon receipt, relays should be examined immediately to ensure no external damage has been sustained in transit. If damage has been sustained, a claim should be made to the transport contractor and Schneider Electric should be promptly notified.

Relays that are supplied unmounted and not intended for immediate installation should be returned to their protective polythene bags and delivery carton. Section 3 of P115/EN IN gives more information about the storage of relays.

2. HANDLING OF ELECTRONIC EQUIPMENT

A person's normal movements can easily generate electrostatic potentials of several thousand volts. Discharge of these voltages into semi-conductor devices when handling electronic circuits can cause serious damage that, although not always immediately apparent can reduce the reliability of the circuit. The relay's electronic circuits are protected from electrostatic discharge when housed in the case. Do not expose them to risk by removing the front panel or printed circuit boards unnecessarily.

Each printed circuit board incorporates the highest practicable protection for its semi-conductor devices. However, if it becomes necessary to remove a printed circuit board, the following precautions should be taken to preserve the high reliability and long life for which the relay has been designed and manufactured.

Before removing a printed circuit board, ensure that you are at the same electrostatic potential as the equipment by touching the case.

Handle analog input modules by the front panel, frame or edges of the circuit boards. Printed circuit boards should only be handled by their edges. Avoid touching the electronic components, printed circuit tracks or connectors.

Do not pass the module to another person without first ensuring you are both at the same electrostatic potential. Shaking hands achieves equipotential.

Place the module on an anti-static surface, or on a conducting surface that is at the same potential as you.

If it is necessary to store or transport printed circuit boards removed from the case, place them individually in electrically conducting anti-static bags.

In the unlikely event that you are making measurements on the internal electronic circuitry of a relay in service, it is preferable that you are earthed to the case with a conductive wrist strap. Wrist straps should have a resistance to ground between 500 kΩ to 10 MΩ. If a wrist strap is not available you should maintain regular contact with the case to prevent a build-up of electrostatic potential. Instrumentation which may be used for making measurements should also be earthed to the case whenever possible.

More information on safe working procedures for all electronic equipment can be found in BS EN 100015: Part 1:1992. It is strongly recommended that detailed investigations on electronic circuitry or modification work should be carried out in a special handling area such as described in the British Standard document.

3. STORAGE

If relays are not to be installed immediately upon receipt, they should be stored in a place free from dust and moisture in their original cartons. Where de-humidifier bags have been included in the packing they should be retained.

Care should be taken on subsequent unpacking that any dust, which has collected on the carton, does not fall inside. In locations of high humidity the carton and packing may become impregnated with moisture and the de-humidifier crystals will lose their efficiency.

Prior to installation, relays should be stored at a temperature of between –25˚C to +70˚C (-13˚F to +158˚F).

4. UNPACKING

Care must be taken when unpacking and installing the relays so that none of the parts are damaged and additional components are not accidentally left in the packing or lost. Ensure that any User's CDROM or technical documentation is NOT discarded – this should accompany the relay to its destination substation.

Relays must only be handled by qualified persons.

The site should be well lit to facilitate inspection, clean, dry and reasonably free from dust and excessive vibration.

5. RELAY MOUNTING

Individual relays are normally supplied with an outline diagram showing the dimensions. This information can also be found in the product publication.

Wall-mounting only is available.

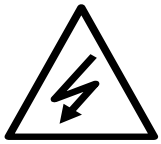
The relay is mounted onto a panel by means of four:

- 4.5mm ∅ drill holes: flush mounting case
- 5.5mm ∅ drill holes: wall mounting case

Detailed drawing with all measurements can be found in Figure 1.

6. RELAY WIRING

Before carrying out any work on the equipment, the user should be familiar with the contents of the Safety Guide SFTY/4L M/E11 or later issue, OR the safety and technical data section of the technical manual and also the ratings on the equipment rating label.



For safety reasons, no work must be carried out on the P115 until all power sources to the unit have been disconnected.

The measuring current inputs of the P115 should be connected to the secondary wires of the power system CTs as shown in the connection diagrams in section 8. ” External Connection Diagram” of this chapter P115/EN IN.

The CT types which can be connected to the P115’s current input terminals are shown in section 3 of the Applications chapter P115/EN AP.

6.1 Terminal block connections

AC Current Input Terminals

Threaded M3 screw-type plug-in terminals, with wire protection for conductor cross-section

- 0.2 - 6mm^2 single-core
- 0.2 - 4mm^2 finely stranded

General Input/Output Terminals

For power supply, binary inputs, output contacts and COM for rear communications.

Threaded M3 screw-type plug-in terminals, with wire protection for conductor cross-section

- 0.2 - 4mm^2 single-core
- 0.2 - 2.5mm^2 finely stranded

Connections to the equipment must only be made using single strand wire or stranded wire with the use of insulated crimp terminals to maintain insulation requirements.

Where UL Listing of the equipment is not required the recommended fuse type for external wiring is a high rupture capacity (HRC) type with a maximum current rating of 16 Amps and a minimum d.c. rating of 250 Vdc, for example the Red Spot NIT or TIA type.

To maintain UL and CUL Listing of the equipment for North America a UL Listed fuse shall be used. The UL Listed type shall be a Class J time delay fuse, with a maximum current rating of 15 A and a minimum d.c. rating of 250 Vdc, for example type AJT15.

The protective fuse(s) should be located as close to the unit as possible.

6.2 USB port

Connection to the USB port can be made by means of an USB cable. The USB port allows the user to download settings or fault records from the P115 or change I/O configuration.

To access this port it is necessary to remove the cover plate (protection against unauthorized setting changes) on the P115 front panel.

A typical cable specification would be:

- Type of cable: USB 2.0
- Connectors:
  - PC: type A male
  - P115: type mini B male

Communication software: MiCOM S1 Studio

The virtual COM port for USB communications should be set in as follows:

Address: 1

Baud rate*:* 115 200 bits/s

Data bit: 8

Stop bit: 1

Parity: None

6.3 Rear Communications Port

EIA(RS)485 signal levels, two wire

Connections located on general purpose block, M3 screw

For screened twisted pair cable, distance to be bridged: multi-endpoint link: max. 100 m

For Modbus RTU or IEC-103 protocol

Isolation to SELV level

7. P115 CASE DIMENSIONS

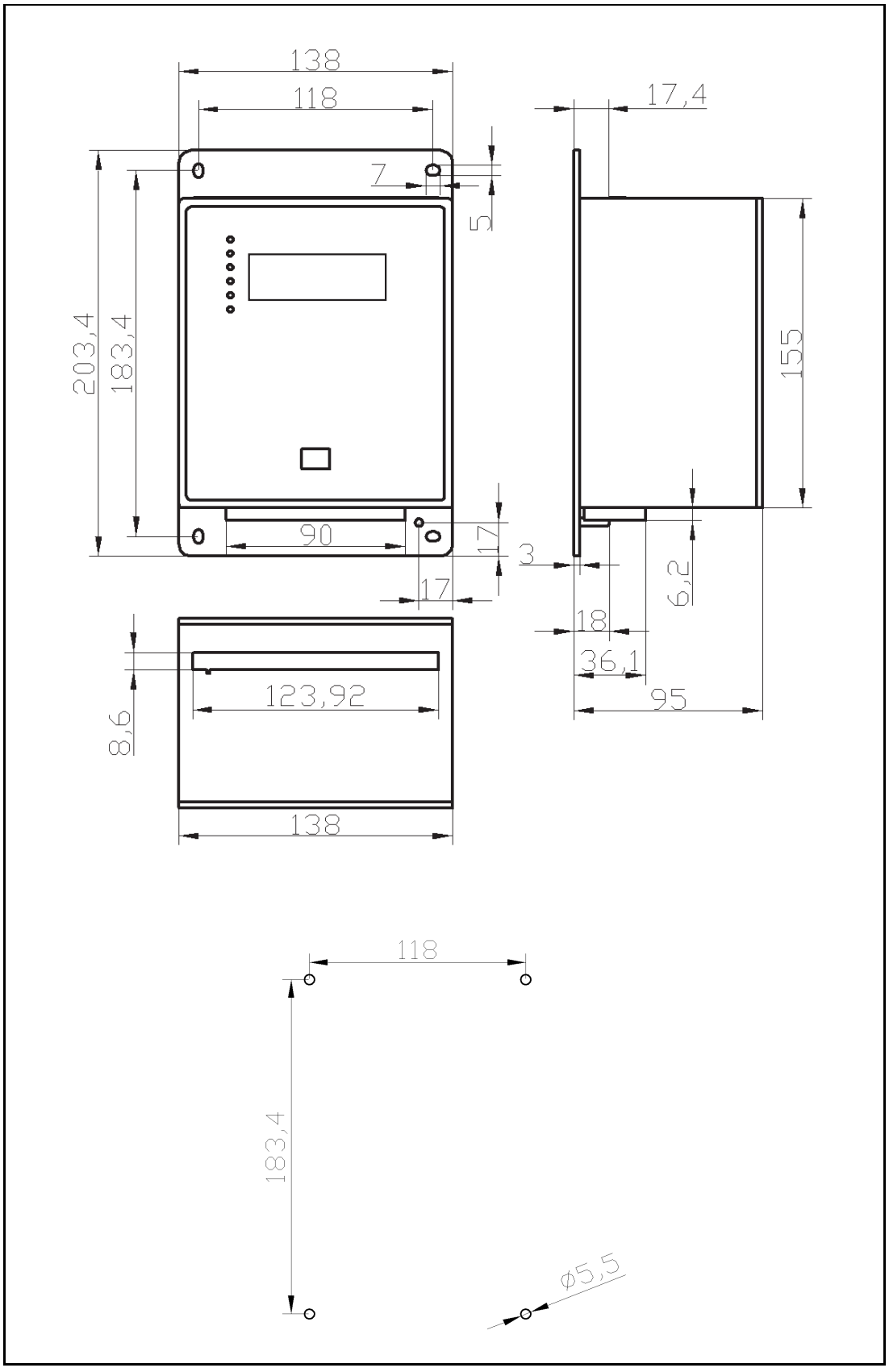


Figure 1: Dimensions. P115 wall mounting case

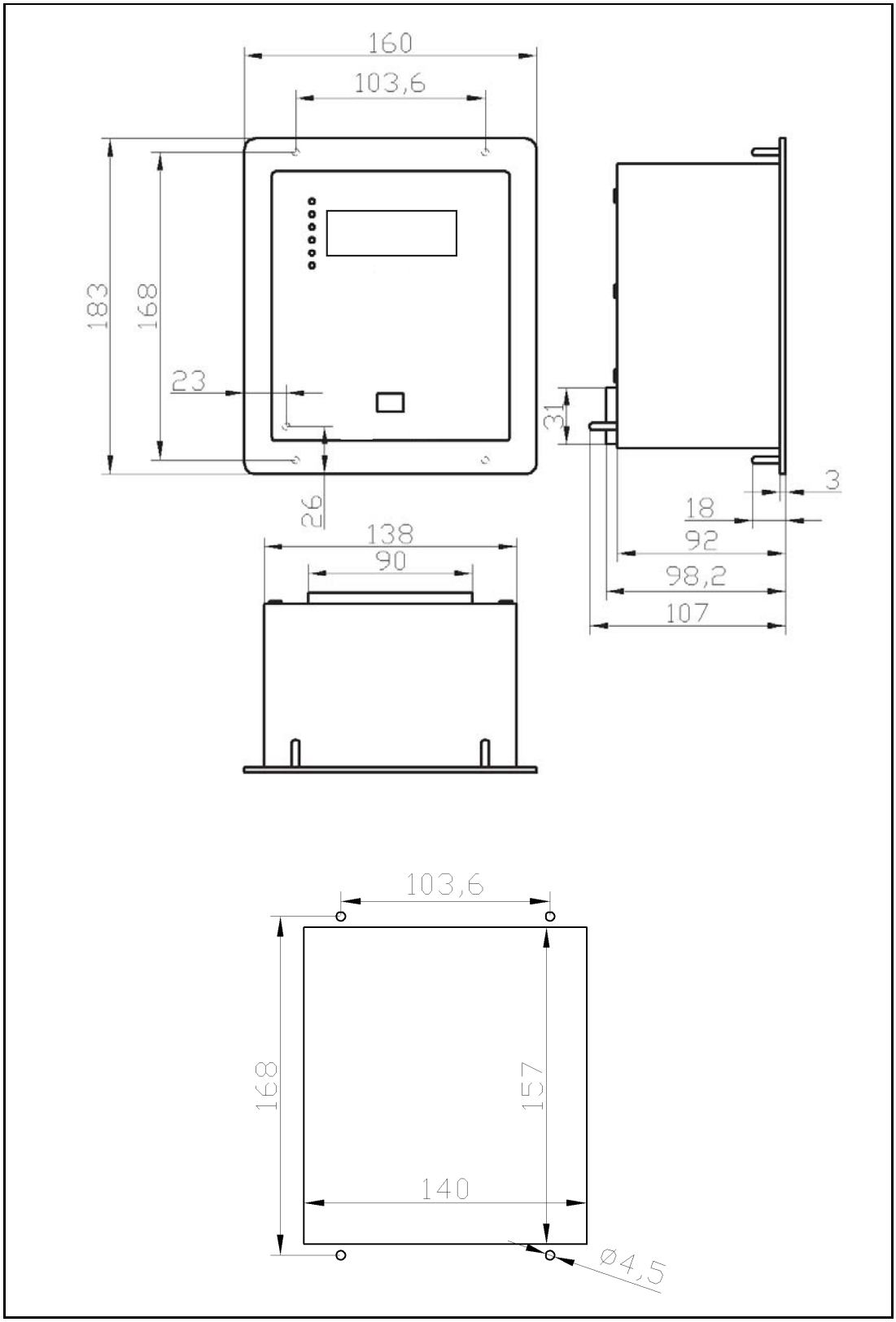


Figure 2: Dimensions. P115 flush mounting case

8. EXTERNAL CONNECTION DIAGRAMS

NOTE: The current leads should be connected exactly as shown on Figures 4 and 5.

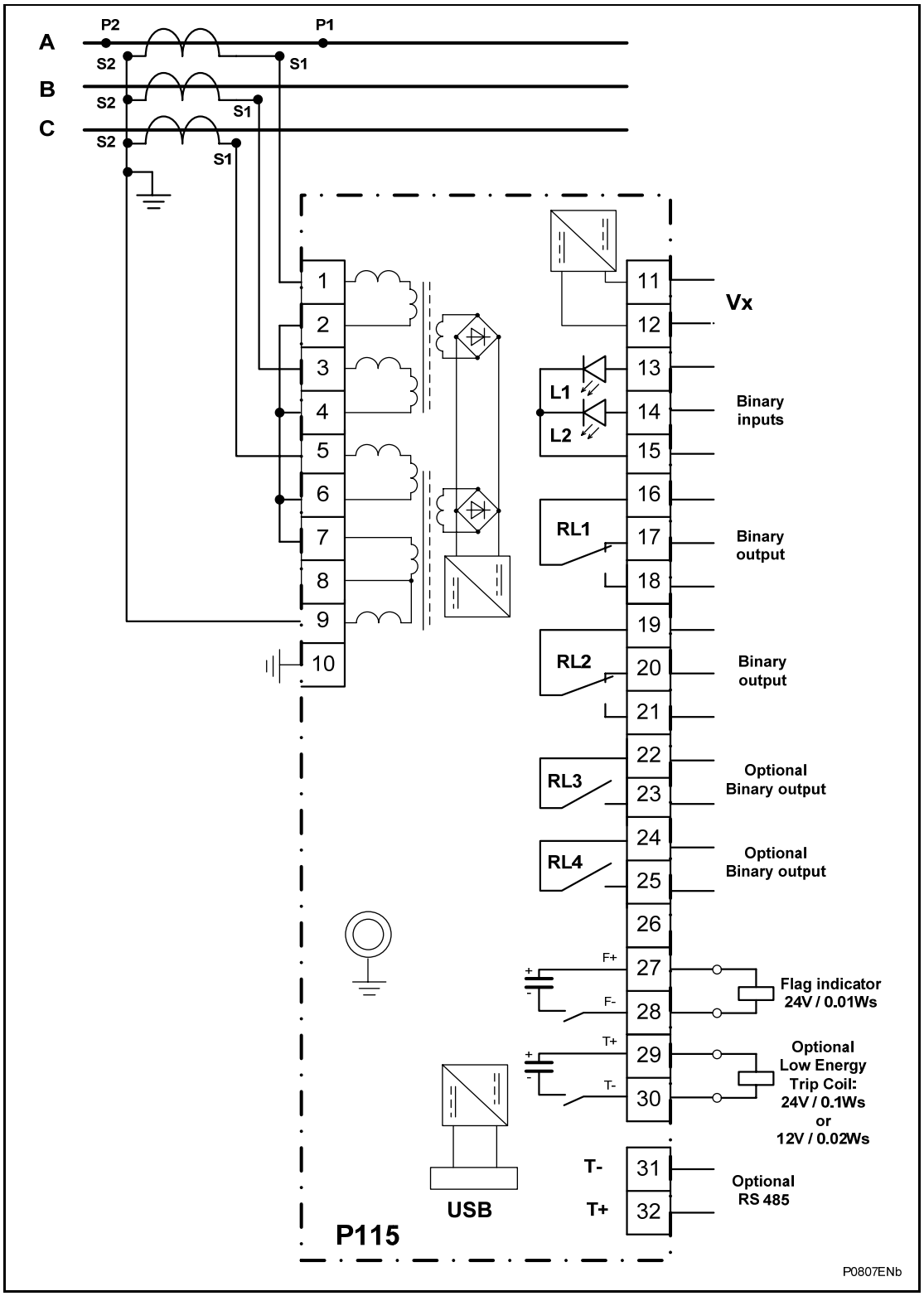


Figure 3: Typical 3 phase CTs connection

IN

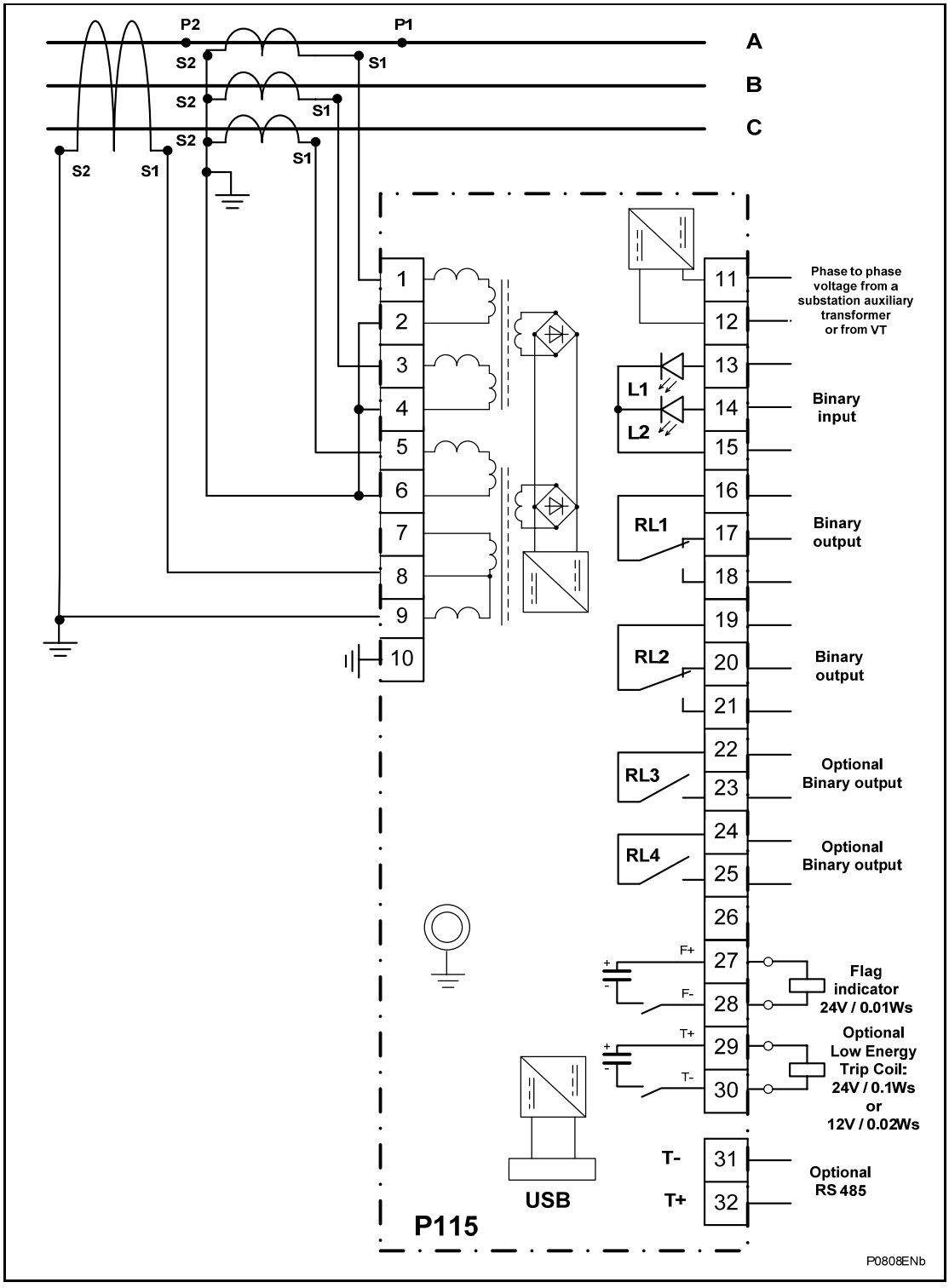


Figure 4: Typical 3 phase CTs + Core balanced CT connection
The P115 is not supplied via a Core Balance CT.
An auxiliary voltage source should be connected to the 11-12 terminals in order to ensure that the P115 is supplied for earth fault currents below 0.2 In.
Refer to Application chapter: P115/EN AP.

IN

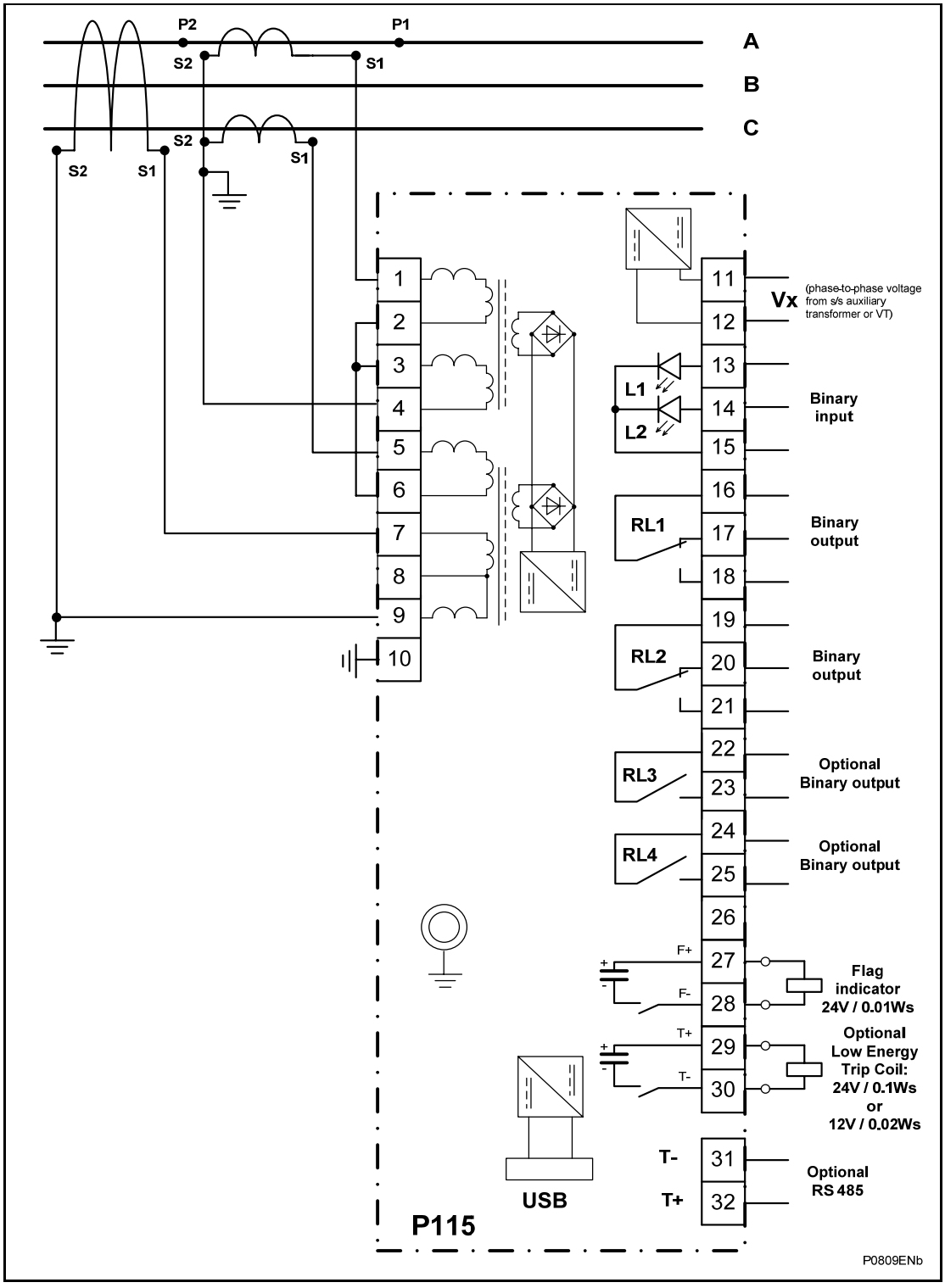


Figure 5: Typical 2 phase CTs + Core balanced CT connection.
The P115 is not supplied via a Core Balance CT.
An auxiliary voltage source should be connected to the 11-12 terminals in order to ensure that the P115 is supplied for earth fault currents below 0.2 In.
If the phase to phase voltage can't be applied (11-12 terminals), a core balanced CT can be connected to 7-9 terminal to supply P115. But this application requires a Core Balanced CT which can provide enough energy to supply the P115 (refer to Application chapter: P115/EN AP).

9. APPLICATION CONNECTION DIAGRAMS

9.1 Tripping the CB using energy from a tripping transfomer

Design of the Main Current Transformers

The main current transformer load is composed essentially of the P115's power consumption, the consumption of the supply conductors wiring, and, in the event of transformer current tripping, the consumption of the tripping transformer that is normally short-circuited on the secondary side. In the event of transformer current tripping the maximum load occurs during closing of the tripping device. The CT requirements of the P115 are given in the technical data chapter. When selecting the main current transformers one should keep in mind that the impedances of the protection device and of the tripping transformer decrease when the current increases, due to saturation. The current transformers rating matching the overcurrent factor and the short-circuit withstand capability can be based on the corresponding low loads. These main current transformers can be considerably overburdened in the nominal current range even when the fault does not exceed the accuracy class rating. Typically, main current transformers having a nominal power rating of 15 VA 10 P10 or 30 VA10 P5 should be provided, but in any case, the required parameters of the main current transformers must be defined as a result of calculation analysis (refer to Application chapter: P115/EN AP).

Connecting the Tripping Transformers

The measured variable is fed into the P115 through the primary winding of the tripping transformer, WA 25 O. During fault-free operation the secondary side of the tripping transformer is short-circuited via one of the P115's contacts. In the event of a trip the contact opens and the circuit breaker is actuated (see Figures 6 to 9).

9.2 Tripping CB using energy provided by an external capacitor unit

Connecting an E124 Capacitor Trip Unit

The MiCOM E124 capacitor trip unit is an auxiliary device typically used to provide energy to the trip coil of a circuit breaker in distribution systems. The trip unit can be used in all cases where a battery and charger would otherwise be necessary to trip the circuit breaker. Such is the case in substations where there is no auxiliary supply, and where protection relays draw their auxiliary power from current and voltage transformer circuits. The easiest way to store the energy for trip coils is in a capacitor trip unit (see Figure 11).

Serially connected with a protection relay, it will release its full energy (300V / 59J) to the trip coil upon closure of the relay's trip contact.

E124 auxiliary supply: 48-230Vac or 48-250Vdc.

E124 key features:

- Extended autonomy (over 8 days without recharge)
- - Two independent capacitor banks, monitored by a microprocessor to guarantee two consecutive trips at maximum power (300V / 59J) without recharge
- Connection in parallel possible to control the trip coil if it requires more than 59J.
- Available output power: 118J (2*59J)
- Output impedance (per capacitor bank): 10 Ohms
- Capacitance: two capacitor banks of 1320 µF each
- Power consumption to charge the capacitors (under 100V): <5 VA or 2.5W
- Power consumption when the capacitors are charged (under 100V): <1.5 VA or 0.25 W

NOTE: The current leads should be connected exactly as shown in Figures 7 to 10.

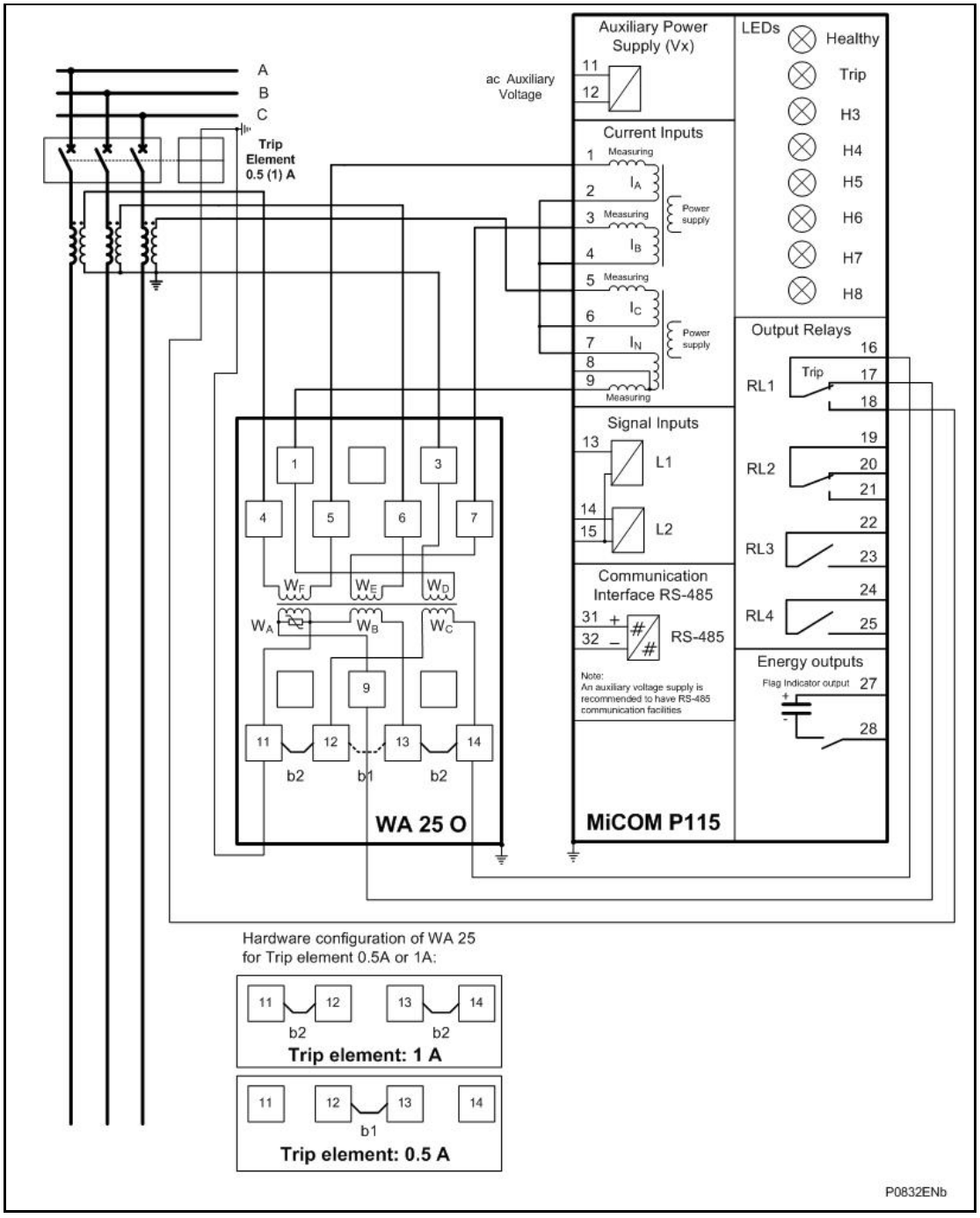


Figure 6: Connection example for a P115 powered by a WA 25 O and with a 4 pole connection (A-B-C-N)

IN

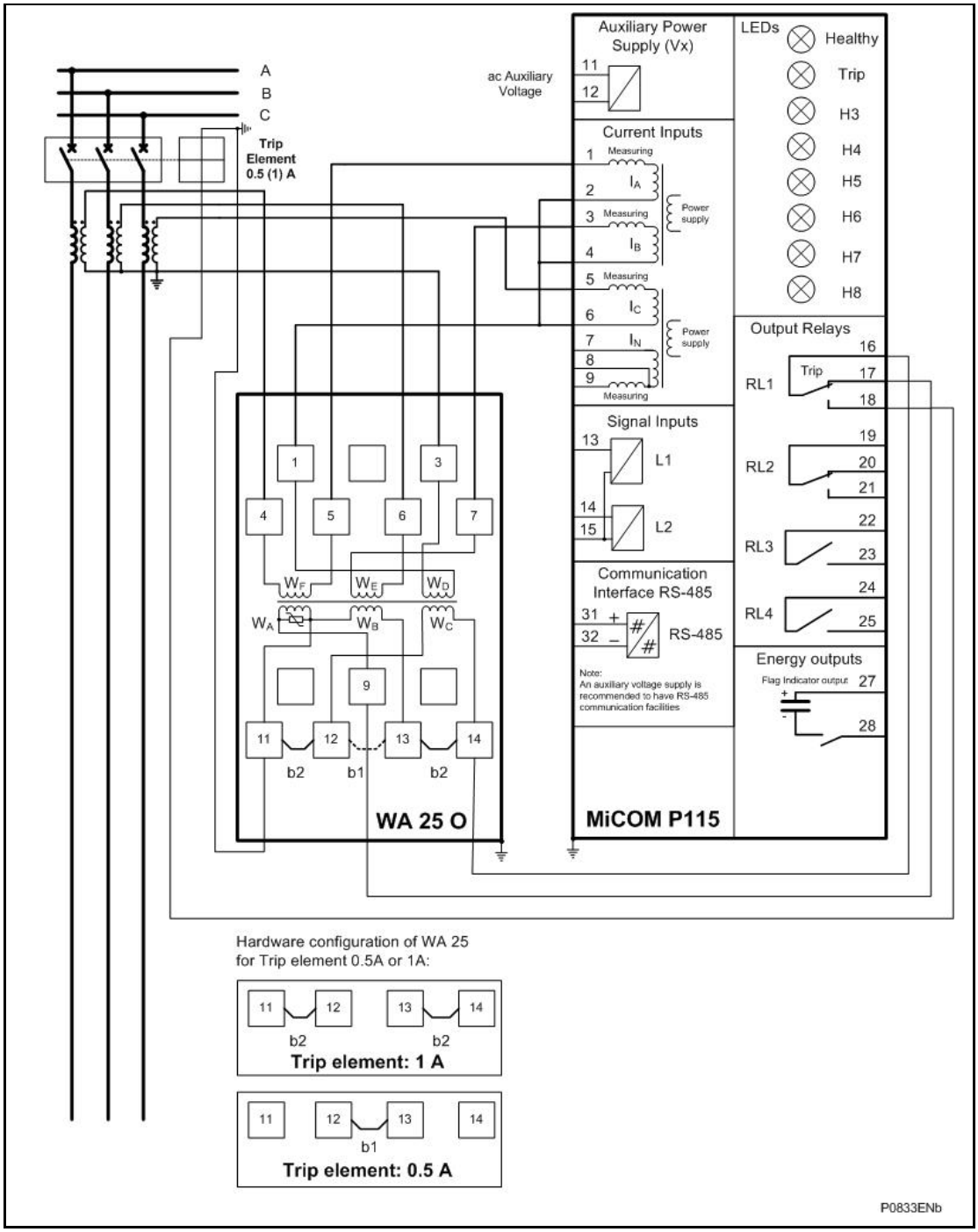


Figure 7: Connection example for a P115 powered by a WA 25 O and with a 3 pole connection (A-B-C)

IN

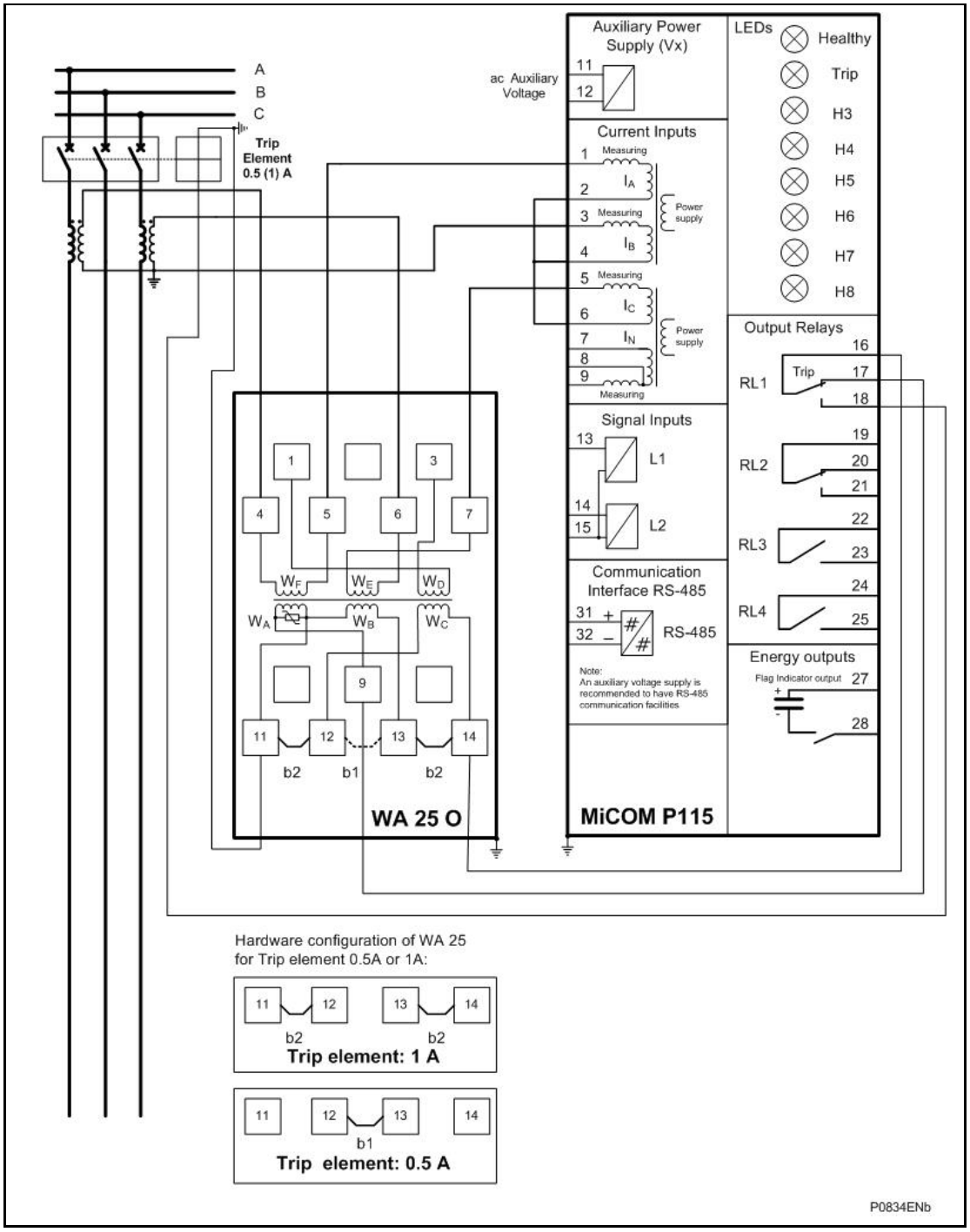


Figure 8: Connection example for a P115 powered by a WA 25 O and with a 2 pole connection (A-C)

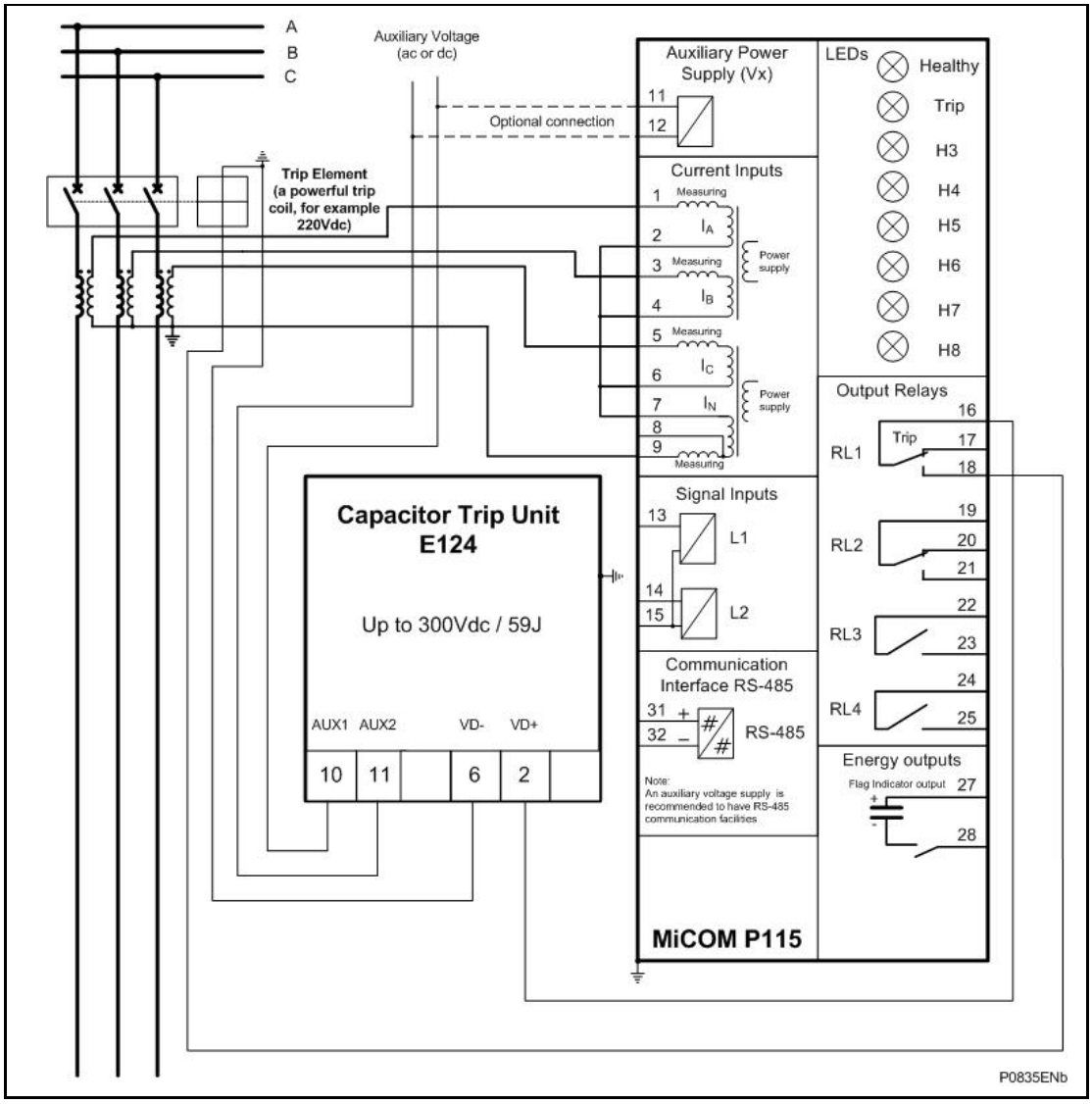


Figure 9: Connection example for a P115 powered by an E124 and with a 4 pole connection (A-B-C-N). The earth input supplies the relay (refer to Application chapter: P115/EN AP).

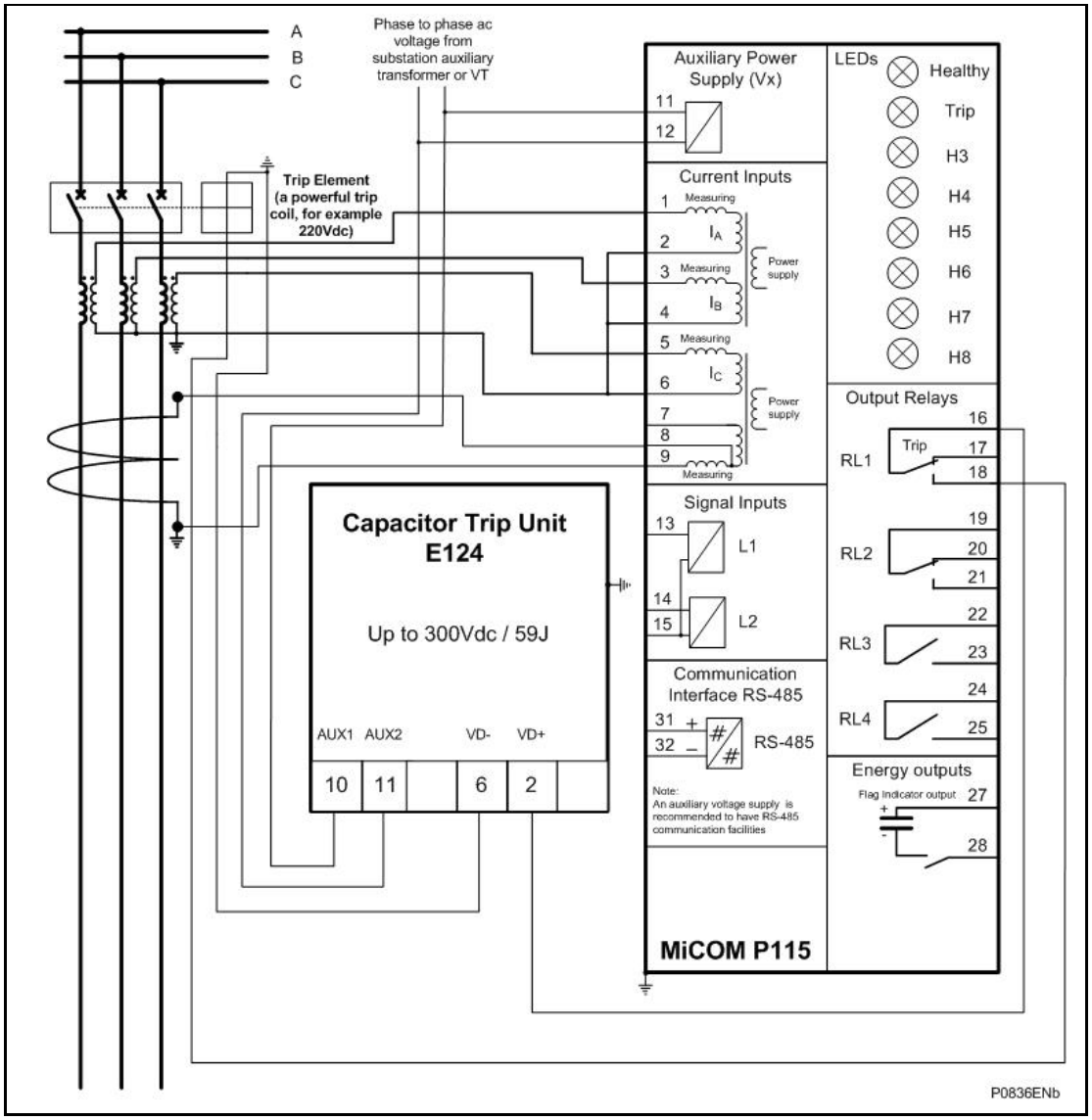


Figure 10: Connection example for a P115 powered by an E124 and with a 4 pole connection (A-B-C-N). The P115 is not supplied via the earth input. (refer to Application chapter: P115/EN AP).

IN

COMMUNICATION DATABASE

CT

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

CT

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1. INTRODUCTION

1.1 Purpose of this document

This document describes the characteristics of the different communication protocol of **MiCOM P115** relay.

The available communication protocols of **MiCOM P115** relay are as follows:

- MODBUS
- IEC 60870-5-103

1.2 Glossary

Ir, Is, It : currents measured on the concerned phases (r, s, t)

I_E : residual current measured by earth input (= 3.I zero sequence)

pf : soft weight of a word of 16 bits

PF : heavy weight of a word of 16 bits

2. MODBUS PROTOCOL

MiCOM P115 relay can communicate by a RS 485 link behind the unit following the MODBUS RTU protocol.

2.1 Technical characteristics of the MODBUS connection

2.1.1 Parameters of the MODBUS connection

The different parameters of the MODBUS connection are as follows:

- Isolated two-point RS485 connection (2kV 50Hz)
- MODBUS line protocol in RTU mode
- Communication speed can be configured by an operator dialog in the front panel of the relay:

Baud rate
4800
9600
38400
57600
115200

Transmission mode of the configured characters by operator dialog:

Mode
1 start / 8 bits / 1 stop: total 10 bits
1 start / 8 bits / even parity / 1 stop: total 11 bits
1 start / 8 bits / odd parity / 1 stop: total 11 bits
1 start / 8 bits / 2 stop: total 11 bits

2.1.2 Synchronisation of exchanges messages

All character received after a silence on the line with more or equal to a transmission time of 3 characters is considered as a firm start.

2.1.3 Message validity check

The frame validity is working with a cyclical redundancy code CRC with 16 bits. The generator polynomial is:

$1 + x^2 + x^{15} + x^{16}$ = 1010 0000 0000 0001 binary = A001h

CT

2.1.4 Address of the MiCOM relays

The address of the MiCOM relay on a same MODBUS network is situated between 1 and 255. The address 0 is reserved for the broadcast messages

2.2 MODBUS functions of the MiCOM relays

The MODBUS functions implemented on the MiCOM relays are:

Function 3 or 4:	Reading of n words
Function 5:	Writing of 1 bit
Function 6:	Writing of 1 word
Function 16:	Writing of n words

2.3 Presentation of the MODBUS protocol

Master slave protocol, all exchange understands a master query and a slave response

Frame size received from **MiCOM P115 Dual-powered** relay

Frame transmitted by the master (query):

Slave number	Function code	Information	CRC1 6
1 byte	1 byte	n bytes	2 bytes
0 à FFh	1 à 10h		

Slave number:

The slave number is situated between 1 and 255.

A frame transmitted with a slave number 0 is globally addressed to all pieces of equipment (broadcast frame)

Function code:

Requested MODBUS function (1 to 16)

Information:

Contains the parameters of the selected function.

CRC16:

Value of the CRC16 calculated by the master.

Note: The MiCOM relay does not respond to globally broadcast frames sent out by the master.

2.3.1 Format of frames sent by the MiCOM relay

Frame sent by the MiCOM relay (response)

Slave number	Function code	Data	CRC16
1 byte	1 byte	n bytes	2 bytes
1 à FFh	1 à 10h		

Slave number:

The slave number is situated between 1 and 255.

Function code:

Processed MODBUS function (1 to 16) .

Data:

Contains reply data to master query .

CRC 16:

Value of the CRC 16 calculated by the slave.

2.3.2 Messages validity check

When **MiCOM P115** relay receive a master query, it validates the frame:

- If the CRC is false, the frame is invalid. **MiCOM P115** relay do not reply to the query. The master must retransmit its query. Excepting a broadcast message, this is the only case of non-reply by **MiCOM P115** relay to a master query.
- If the CRC is good but the MiCOM relay can not process the query, it sends an exception response.

Warning frame sent by the MiCOM relay (response)

Slave number	Function code	Warning code	CRC16
1 byte	1 byte	1 byte	2 bytes
1 to FFh	81h or 83h or 8Ah or 8Bh		pf ... PF

Slave number:

The slave number is situated between 1 and 255.

Function code:

The function code returned by the MiCOM relay in the warning frame is the code in which the most significant bit (b7) is forced to 1.

Warning code:

On the 8 warning codes of the MODBUS protocol, the MiCOM relay manages two of them:

- code 01: function code unauthorised or unknown.
- code 03: a value in the data field is unauthorised (incorrect data).

Control of pages being read

Control of pages being written

Control of addresses in pages

Length of request messages

CRC16:

Value of the CRC16 calculated by the slave.

2.4 MiCOM P115 Dual-powered relay database organisation

2.4.1 Description of the application mapping

2.4.1.1 Settings

MiCOM P115 application mapping has 9 pages of parameters.

Page 0h: Product information, remote signalling, measurements

Page 1h: General remote parameters

Page 2h: Setting group 1 remote parameters

Page 3h: Setting group 2 remote parameters

Page 4h: Remote controls

Pages 5h/6h: Reserved pages

Pages 7h: Quick reading byte

Pages 8h: Time synchronisation

2.4.1.2 Event records

To upload the event records two requests are allowed:

Page 35h: Request to upload an event record without acknowledge of this event.

Used addresses:

3500h: EVENT 1

.....
3563h: EVENT 100

Page 36h: Request to upload the non-acknowledged oldest stored event record.

Two modes are available for the acknowledgement: automatic acknowledgement or manual acknowledgement.

The mode depends of the state of bit 12 of telecommand word (address 400 h).

If this bit is set, then the acknowledgement is manual else the acknowledgement is automatic.

In automatic mode, the reading of the event acknowledges the event.

In manual mode, it is necessary to write a specific command to acknowledge the oldest event.

(set the bit 13 of control word 400 h)

2.4.1.3 Fault records

CT

Page 37h: Page dedicated to upload fault record

Used addresses:

3700h: FAULT 1
3701h: FAULT 2

.....
3704h: FAULT 5

Page 3Eh: Request to upload the non-acknowledged oldest stored fault record.

Two modes are available for the acknowledgement: automatic acknowledgement or manual acknowledgement.

The mode depends of the state of bit 12 of telecommand word (address 400 h).

If this bit is set, then the acknowledgement is manual else the acknowledgement is automatic.

In automatic mode, the reading of the fault acknowledges automatically the event.

In manual mode, it is necessary to write a specific command to acknowledge the oldest fault.

(set the bit 14 of control word 400 h)

2.4.1.4 Characteristics

Page 0h can only be read through communication.

Pages 1h, 2h, 3h and 4h can be read and write.

Page 7h can be access in quick reading only.

Page 8h can be write.

They are describe more precisely in the following chapters.

2.4.2 Page 0h: Product information, remote signalling, measurements

Read access only

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0000	**Product Information**	Relay description characters 1 and 2	32-127	1	-	F10	P1
0001		Relay description characters 3 and 4	32-127	1	-	F10	15
0002		Relay description characters 5 and 6	32-127	1	-	F10	
0003		Unit reference characters 1 and 2	32-127	1	-	F10	AR
0004		Unit reference characters 3 and 4	32-127	1	-	F10	EV
0005		Software Version	10 to 99		-	F15	12
0006		Hardware Version	0 to 3		-	F17	
0007		Line CT Sec	0 to 1		-	F23	
0008		E/Gnd CT Sec	0 to 1		-	F31	
0009		Active Set Group	0 to 1		-	F32	0
000A		Reserved			-		
000B		Hardware Warning	0 to 15		bits	F26	0
000C-000F		*Reserved*			-		
0010	**Remote signalling**	Logical inputs	0 to 15	1	bits	F11	
0011		Protection disable status	0 to 15	1	bits	F12	
0012		Output contacts	0 to 15	1	bits	F24	
0013		Logical LEDs status	0 to 15	1	bits	F25	
0014		Output information: Protection starting status	0 to 15	1	bits	F28	
0015		Output information: Protection trip status	0 to 16	1	bits	F29	
0016		CB status	0 to 15	1	-	F30	
0017-0018		Reserved					
0019		Output information: I>	0 to 15	1	bits	F37	
001A		Output information: I>>	0 to 15	1	bits	F37	
001B		Output information: I>>>	0 to 15	1	bits	F37	
001C		Output information: IN>	0 to 15	1	bits	F50	
001D		Output information: IN>>	0 to 15	1	bits	F50	
001E		Output information: Iasym>	0 to 15	1	bits	F51	
001F		Output information: AUX1	0 to 15	1	bits	F51	
0020		Output information: AUX2	0 to 15	1	bits	F51	
0021		Output information: CB Fail	0 to 15	1	bits	F51	
0022		Output information: CB ext.	0 to 15	1	bits	F51	
0023 to 002F		Reserved					

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0030	**Remote measurements**	Phase A current RMS value	0 to 60 000	1	[A]/100	F1	
0031		Phase B current RMS value	0 to 60 000	1	[A]/100	F1	
0032		Phase C current RMS value	0 to 60 000	1	[A]/100	F1	
0033		Earth current RMS value	0 to 60 000	1	[A] x 100	F1	
0034		Asymmetry current RMS value	0 to 60 000		[A] x 100	F1	
0035-004F		Reserved					
0050		Phase A current RMS value	0 to 60 000		[In]	F1	
0051		Phase B current RMS value	0 to 60 000	1	[In]	F1	
0052		Phase C current RMS value	0 to 60 000	1	[In]	F1	
0053		Earth current RMS value	0 to 60 000	1	[Ien]	F1	
0054		Asymmetry current RMS value	0 to 60 000	1	[In]	F1	
0055-00FF		Reserved					

2.4.3 Page 1h, MiCOM P115: general remote parameters

Read and write access

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0100	**Remote parameters**	Address	1 to 127	1	-	F1	1
0101		Protocol for RS485	0 to 1	1		F56	0
0002-010F		Reserved					
0110	**Counters**	Trips Nb	0 to 65535	1	-	F1	0
0111		Reserved			-	F1	
0112		Fault Trips Nb	0 to 65535	1	-	F1	0
0113		Fault Start Nb	0 to 65535	1	-	F1	0
0114		Alarm Nb	0 to 65535	1	-	F1	0
0115		HW Warnings Nb	0 to 65535	1	-	F1	0
0116-011F		Reserved					
0120	**CT Ratio**	**Line CT primary**	1 to 30000	1	A	F1	
0121		Reserved					
0122		E/Gnd CT Primary	1 to 30000	1	A	F1	
0123-012F		Reserved					
0130	**RS485 Settings**	**Baud Rate**	0 to 5	1	-	F19	2
0131		Parity	0 to 2	1	-	F20	0
0132		Stop bits	0 to 1	1	-	F22	0
0133-013F		Reserved					
0140	**General Settings**	**Language**	0 to 5	1	-	F52	0
0141		Default display	0 to 2	1	-	F53	0
0142		LEDs Reset by	0 to 1	1	-	F54	0
0143		Alarm Display Reset	0 to 1	1	-	F55	0
0144-014F		Reserved					
0150		Setting group change	0 to 1	1	-	F32	0
0151-017F		Reserved					
0180		tOpen pulse min	1 to 1000	1	1/100 s	F1	50
0181		tClose Pulse	1 to 1000	1	1/100 s	F1	50
0182		tP Pulse	1 to 65000	1	mn	F1	1
0183		tCB not Healthy	1 to 200	1	s	F1	16
0184		t Change Setting G1->G2	0 to 20000	1	1/100 s	F13	0
0185-01FF		Reserved					

2.4.4 Page 2h: setting Group 1

Access in reading and in writing

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0200	Setting group 1 Protection	I> ?	0-2	1	-	F16	1
0201		I> threshold	20 to 4000	1	In/100	F1	140
0202		ItI>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0203		I> Delay Type	0 to 12	1	-	F18	1
0204		I> Reset Delay Type	0 -1	25	-	F41	0
0205		I> DMT tReset	0 to 20000	5	1/100 s	F1	0
0206-020F		Reserved					
0210		I>>?	0-2	1	-	F16	0
0211		I>> Threshold	20 to 4000	5	In/100	F1	140
0212		tI>>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0213		*I>> Delay Type*	0 to 12		-	F18	1
0214		*I>> Reset Delay Type*	0 -1		-	F41	0
0215		*I>> DMT tReset*	0 to 20000		1/100 s	F1	0
0216-021F		*Reserved*					
0220		*I>>>?*	0-2		-	F16	0
0221		I>>> Threshold	20 to 4000	5	In/100	F1	400
0222		tI>>>	0 to 20000	1	1/100 s	F1	100
0223-022F		*Reserved*					
0230		IN>?	0-2	1	-	F16	0
0231		IN> Threshold		1	Ien/100	F1	10 50 100
0232		tIN>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0233		IN> Delay Type	0 to 12	25	-	F18	1
0234		IN> Reset Delay Type	0 -1	5	-	F41	0
0235		IN> DMT tReset	0 to 20000	1	1/100 s	F1	0
0236-023F		Reserved					
0240		IN>>?	0-2	0-2	-	F16	0
0241		IN>> Threshold	4 to 10000	1	Ien/100	F1	options
0242		tIN>>	0 to 20000	1	1/100 s	F1	10
0243 to 024F		*Reserved*					
0250		Iasym>?	0-2	1	-	F16	0
0251		Iasym> Threshold	8 to 4000	1	In/100	F1	20
0252		tIasym>	0 to 20000	1	1/100 s	F1	1000
0253 to 025F		*Reserved*					
0260		AUX1?	0-2	1	-	F16	0

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0261		tAUX1	0 to 20000	5	1/100 s	F1	1000
0262-0269		Reserved					
026A		AUX2?	0-2	1	-	F16	0
026B		tAUX2	0 to 20000	5	1/100 s	F1	1000
026C-026F		Reserved					
0270		CB Fail?	0-2	1	-	F16	0
0271		CB Fail Time tBF	0 to 1000	1	1/100 s	F1	20
0272		I< Threshold CBF	5 to 400	1	In/100	F1	10
0273		IN< Threshold CBF	5 to 1000	1	Ien/100	F1	10
0274-028F		Reserved					
0290	Setting group 1 Inputs	Reverse Input Logic	0 to 1	1	bits	F35	00
0291		Blocked Outputs	0 to 1	1	bits	F35	00
0292		Reset Latchd LEDs	0 to 1	1	bits	F35	00
0293		Reset Latchd Outp	0 to 1	1	bits	F35	00
0294		Blocking I>	0 to 1	1	bits	F35	00
0295		Blocking I>>	0 to 1	1	bits	F35	00
0296		Blocking I>>>	0 to 1	1	bits	F35	00
0297		Blocking IN>	0 to 1	1	bits	F35	00
0298		Blocking IN>>	0 to 1	1	bits	F35	00
0299		Blocking Iasym>	0 to 1	1	bits	F35	00
029A		Blocking AUX1	0 to 1	1	bits	F35	00
029B		*Blocking AUX2*	0 to 1	1	bits	F35	00
029C		Blocking CB Fail	0 to 1	1	bits	F35	00
029D		AUX1	0 to 1	1	bits	F35	00
029E		AUX2	0 to 1	1	bits	F35	00
029F		CBF ext.	0 to 1	1	bits	F35	00
02A0		CB status 52A	0 to 1	1	bits	F35	00
02A1		*CB status 52B*	0 to 1	1	bits	F35	00
02A2		CB not Healthy	0 to 1	1	bits	F36	00
02A3		Setting Group 2	0 to 1	1	bits	F36	00
02A4-02AF		Reserved					
02B0	Setting group 1 Outputs	Latched outputs	0 to 1	1	bits	F36	0100
02B1		Reverse outp. Logic	0 to 1	1	bits	F36	0000
02B2		Protect. Trip	0 to 1	1	bits	F40	110000
02B3		Trip (pulse)	0 to 1	1	bits	F33	00001
02B4		Alarm	0 to 1	1	bits	F33	00000
02B5		Start I>	0 to 1	1	bits	F36	0000
02B6		Start I>>	0 to 1	1	bits	F36	0000
02B7		Start I>>>	0 to 1	1	bits	F36	0000
02B8		Start IN>	0 to 1	1	bits	F36	0000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
02B9		Start IN>>	0 to 1	1	bits	F36	0000
02BA		Start Iasym>	0 to 1	1	bits	F36	0000
02BB		Start AUX1	0 to 1	1	bits	F36	0000
02BC		Start AUX2	0 to 1	1	bits	F36	0000
02BD		tI>	0 to 1	1	bits	F40	0000
02BE		tI>>	0 to 1	1	bits	F40	0000
02BF		tI>>>	0 to 1	1	bits	F40	0000
02C0		tIN>	0 to 1	1	bits	F40	0000
02C1		tIN>>	0 to 1	1	bits	F40	0000
02C2		tIasym>	0 to 1	1	bits	F40	0000
02C3		CB Fail	0 to 1	1	bits	F40	0000
02C4		CBF ext.	0 to 1	1	bits	F40	0000
02C5		tAUX1	0 to 1	1	bits	F40	0000
02C6		tAUX2	0 to 1	1	bits	F40	0000
02C7		Trip pulse tP	0 to 1	1	bits	F36	0000
02C8		Close CB (remote or from HMI)	0 to 1	1	bits	F36	0000
02C9		Trip CB (remote or from HMI)	0 to 1	1	bits	F40	0000
02CA		tCB not Healthy	0 to 1	1	bits	F33	0000
02CB		Hardware Warning	0 to 1	1	bits	F33	0000
02CC		Start Phase A	0 to 1	1	bits	F36	0000
02CD		Start Phase B	0 to 1	1	bits	F36	0000
02CE		Start Phase C	0 to 1	1	bits	F36	0000
02CF		Start Earth	0 to 1	1	bits	F36	0000
02E0	Setting group 1 LEDs	Latched LEDs	0 to 1	1	bits	F39	111111
02E1		Protect. Trip	0 to 1	1	bits	F39	000000
02E2		Alarm	0 to 1	1	bits	F39	000000
02E3		Start I>	0 to 1	1	bits	F39	000000
02E4		Start I>>	0 to 1	1	bits	F39	000000
02E5		Start I>>>	0 to 1	1	bits	F39	000000
02E6		Start IN>	0 to 1	1	bits	F39	000000
02E7		Start IN>>	0 to 1	1	bits	F39	000000
02E8		Start Iasym>	0 to 1	1	bits	F39	000000
02E9		Start AUX1	0 to 1	1	bits	F39	000000
02EA		Start AUX2	0 to 1	1	bits	F39	000000
02EB		tI>	0 to 1	1	bits	F39	000000
02EC		tI>>	0 to 1	1	bits	F39	000000
02ED		tI>>>	0 to 1	1	bits	F39	000000
02EE		tIN>	0 to 1	1	bits	F39	000000
02EF		tIN>>	0 to 1	1	bits	F39	000000
02F0		tIasym>	0 to 1	1	bits	F39	000000
02F1		CB Fail	0 to 1	1	bits	F39	000000
02F2		CBF ext.	0 to 1	1	bits	F39	000000
02F3		tAUX1	0 to 1	1	bits	F39	000000
02F4		tAUX2	0 to 1	1	bits	F39	000000
02F5		CB not Healthy	0 to 1	1	bits	F39	000000
02F6		Setting Group 1	0 to 1	1	bits	F39	000000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
02F7		Start Phase A	0 to 1	1	bits	F39	000000
02F8		Start Phase B	0 to 1	1	bits	F39	000000
02F9		Start Phase C	0 to 1	1	bits	F39	000000
02FA		Start Earth	0 to 1	1	bits	F39	000000
02FB-02FF		Reserved					

2.4.5 Page 3h: setting Group 2

Access in reading and in writing

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0300	Setting group 1 Protection	I> ?	0-2	1	-	F16	1
0301		I> threshold	20 to 4000	1	In/100	F1	110
0302		ItI>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0303		I> Delay Type	0 to 12	1	-	F18	1
0304		I> Reset Delay Type	0 -1	25	-	F41	0
0305		I> DMT tReset	0 to 20000	5	1/100 s	F1	0
0306-030F		Reserved					
0310		I>>?	0-2	1	-	F16	0
0311		I>> Threshold	20 to 4000	5	In/100	F1	140
0312		tI>>/TMS/TD	2 to 20000	1	1/100 s	F13	100
0313		*I>> Delay Type*	0 to 12		-	F18	1
0314		*I>> Reset Delay Type*	0 -1		-	F41	0
0315		*I>> DMT tReset*	0 to 20000		1/100 s	F1	0
0316-031F		*Reserved*					
0320		*I>>>?*	0-2		-	F16	1
0321		I>>> Threshold	20 to 4000	5	In/100	F1	400
0322		tI>>>	0 to 20000	1	1/100 s	F1	100
0323-032F		*Reserved*					
0330		IN>?	0-2	1	-	F16	1
0331		IN> Threshold		1	Ien/100	F1	10 50 100
0332		tIN>/TMS/TD	2 to 20000	1	1/100 s	F1	100
0333		IN> Delay Type	0 to 12	25	-	F18	1
0334		IN> Reset Delay Type	0 -1	5	-	F41	0
0335		IN> DMT tReset	0 to 20000	1	1/100 s	F1	0
0336-033F		Reserved					
0340		IN>>?	0-2	0-2	-	F16	1
0341		IN>> Threshold	4 to 10000	1	Ien/100	F1	50
0342		tIN>>	0 to 20000	1	1/100 s	F1	10
0343 to 034F		*Reserved*					
0350		Iasym>?	0-2	1	-	F16	0
0351		Iasym> Threshold	8 to 4000	1	In/100	F1	20
0352		tIasym>	0 to 20000	1	1/100 s	F1	1000
0353 to 035F		*Reserved*					
0360		AUX1?	0-2	1	-	F16	0

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0361		tAUX1	0 to 20000	5	1/100 s	F1	1000
0362-0369		Reserved					
036A		AUX2?	0-2	1	-	F16	0
036B		tAUX2	0 to 20000	5	1/100 s	F1	1000
036C-036F		Reserved					
0370		CB Fail?	0-2	1	-	F16	0
0371		CB Fail Time tBF	0 to 1000	1	1/100 s	F13	20
0372		I< Threshold CBF	5 to 400	1	In/100	F13	10
0373		IN< Threshold CBF	5 to 1000	1	Ien/100	F13	10
0374-038F		Reserved					
0390	Setting group 2 Inputs	Reverse Input Logic	0 to 1	1	bit	F35	00
0391		Blocked Outputs	0 to 1	1	bit	F35	00
0392		Reset Latchd LEDs	0 to 1	1	bit	F35	10
0393		Reset Latchd Outp	0 to 1	1	bit	F35	10
0394		Blocking I>	0 to 1	1	bit	F35	00
0395		Blocking I>>	0 to 1	1	bit	F35	01
0396		Blocking I>>>	0 to 1	1	bit	F35	00
0397		Blocking IN>	0 to 1	1	bit	F35	00
0398		Blocking IN>>	0 to 1	1	bit	F35	00
0399		Blocking Iasym>	0 to 1	1	bit	F35	00
039A		Blocking AUX1	0 to 1	1	bit	F35	00
039B		*Blocking AUX2*	0 to 1	1	bit	F35	00
039C		Blocking CB Fail	0 to 1	1	bit	F35	00
039D		AUX1	0 to 1	1	bit	F35	00
039E		AUX2	0 to 1	1	bit	F35	00
039F		CBF ext.	0 to 1	1	bit	F35	00
03A0		CB status 52A	0 to 1	1	bit	F35	00
03A1		*CB status 52B*	0 to 1	1	bit	F35	00
03A2		CB not Healthy	0 to 1	1	bit	F36	00
03A3		Setting Group 2	0 to 1	1	bit	F36	00
03A4-03AF		Reserved					
03B0	Setting group 2 Outputs	Latched outputs	0 to 1	1	bit	F36	0100
03B1		Reverse outp. Logic	0 to 1	1	bit	F36	0000
03B2		Protect. Trip	0 to 1	1	bit	F40	0111
03B3		Trip (pulse)	0 to 1	1	bit	F33	0000
03B4		Alarm	0 to 1	1	bit	F33	0000
03B5		Start I>	0 to 1	1	bit	F36	0000
03B6		Start I>>	0 to 1	1	bit	F36	0000
03B7		Start I>>>	0 to 1	1	bit	F36	0000
03B8		Start IN>	0 to 1	1	bit	F36	0000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
03B9		Start IN>>	0 to 1	1	bit	F36	0000
03BA		Start Iasym>	0 to 1	1	bit	F36	0000
03BB		Start AUX1	0 to 1	1	bit	F36	0000
03BC		Start AUX2	0 to 1	1	bit	F36	0000
03BD		tI>	0 to 1	1	bit	F40	0000
03BE		tI>>	0 to 1	1	bit	F40	0000
03BF		tI>>>	0 to 1	1	bit	F40	0000
03C0		tIN>	0 to 1	1	bit	F40	0000
03C1		tIN>>	0 to 1	1	bit	F40	0000
03C2		tIasym>	0 to 1	1	bit	F40	0000
03C3		CB Fail	0 to 1	1	bit	F40	0000
03C4		CBF ext.	0 to 1	1	bit	F40	0000
03C5		tAUX1	0 to 1	1	bit	F40	0000
03C6		tAUX2	0 to 1	1	bit	F40	0000
03C7		Trip pulse tP	0 to 1	1	bit	F36	0000
03C8		Close CB (remote or from HMI)	0 to 1	1	bit	F36	0000
03C9		Trip CB (remote or from HMI)	0 to 1	1	bit	F40	0000
03CA		tCB not Healthy	0 to 1	1	bit	F33	0000
03CB		Hardware Warning	0 to 1	1	bit	F33	0000
03CC		Start Phase A	0 to 1	1	bit	F36	
03CD		Start Phase B	0 to 1	1	bit	F36	
03CE		Start Phase C	0 to 1	1	bit	F36	
03CF		Start Phase Earth	0 to 1	1	bit	F36	
03D0-03DF		Reserved					
03E0	Setting group 2 LEDs	Latched LEDs	0 to 1	1	bit	F39	111111
03E1		Protect. Trip	0 to 1	1	bit	F39	000000
03E2		Alarm	0 to 1	1	bit	F39	000000
03E3		Start I>	0 to 1	1	bit	F39	000000
03E4		Start I>>	0 to 1	1	bit	F39	000000
03E5		Start I>>>	0 to 1	1	bit	F39	000000
03E6		Start IN>	0 to 1	1	bit	F39	000000
03E7		Start IN>>	0 to 1	1	bit	F39	000000
03E8		Start Iasym>	0 to 1	1	bit	F39	000000
03E9		Start AUX1	0 to 1	1	bit	F39	000000
03EA		Start AUX2	0 to 1	1	bit	F39	000000
03EB		tI>	0 to 1	1	bit	F39	000000
03EC		tI>>	0 to 1	1	bit	F39	000000
03ED		tI>>>	0 to 1	1	bit	F39	000000
03EE		tIN>	0 to 1	1	bit	F39	000000
03EF		tIN>>	0 to 1	1	bit	F39	000000
03F0		tIasym>	0 to 1	1	bit	F39	000000
03F1		CB Fail	0 to 1	1	bit	F39	000000
03F2		CBF ext.	0 to 1	1	bit	F39	000000
03F3		tAUX1	0 to 1	1	bit	F39	000000
03F4		tAUX2	0 to 1	1	bit	F39	000000

Address	Group	Description	Values range	Step	Unit	Format	Default Value
03F5		CB not Healthy	0 to 1	1	bit	F39	000000
03F6		Setting Group 2	0 to 1	1	bit	F39	000000
03F7		Start Phase A	0 to 1	1	bit	F39	000000
03F8		Start Phase B	0 to 1	1	bit	F39	000000
03F9		Start Phase C	0 to 1	1	bit	F39	000000
03FA		Start Phase Earth	0 to 1	1	bit	F39	000000
03F7		Reserved					

2.4.6 Page 4h: remote controls

Access in writing

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0400	**Remote control**	Remote control word 1	0 to 15	1	-	F38	0

2.4.7 Pages 5h/6h

These pages are reserved

2.4.8 Page 7h

Access in quick reading only (MODBUS 07 function)

Address	Group	Description	Values range	Step	Unit	Format	Default Value
0700	**Quick reading byte**	Relay status description		1	-	F49	0

2.4.9 Page 8h: time synchronisation

Access in writing for n words (function 16). The time synchronisation format is based on 8 bits (4 words) (Inverted IEC 870-5-4 CP56Time2a):

Timer	Address (hex)	Nb bytes	Mask (hex)	Values range	Unit
	0800	1 (Hi)			
Year		1 (Lo)	7F	0 – 99 (2000-2093)	Year
Month	0801	1 (Hi)	0F	1 - 12	month
Day of week		1 (Lo)	E0	1 – 7 (Monday – Sunday)	Day
day of month		1 (Lo)	1F	1 – 31	Day
Season	0802	1 (Hi)	80	0 – 1 (summer-winter) Not used	
Hour		1 (Hi)	1F	0-23	Hour
Invalidity		1 (Lo)	80	0 -1 (valid – invalid)	
Minute		1 (Lo)	3F	0-59	Minute
Millisecond pF+pf	0803	2	FFFF	0 – 59999	ms

2.4.10 Mapping access characteristics

- Description of accessible addresses in reading of words (**function 03** and **04**).

PAGE 00h
0000h to 0054h

PAGE 01h
0100h to 0184h

PAGE 02h
0200h to 02FAh

PAGE 03h
0300h to 03F6h

- Definition of accessible addresses in writing of 1 word (**function 06**).

PAGE 01h
0100h to 0184h

PAGE 02h
0200h to 02FAh

PAGE 03h
0300h to 03FAh

- Definition of accessible addresses in writing of n words (**function 16).**

PAGE 01h
0100h to 0184h

PAGE 02h
0200h to 02FAh

PAGE 03h
0300h to 03FAh

PAGE 08h
0800h to 0803h

- Definition of accessible addresses in reading of bits (**function 01** and **02**).

Not available

- Definition of accessible addresses in writing of 1 bit (**function 05**).

WARNING: THE BITS NUMBER MUST NOT BE HIGHER THAN 16.

2.4.11 Page 35h (addresses 3500h to 354Ah): event record data (9 words)

Word n° 1: Event meaning

Word n° 2: MODBUS associated value

Word n° 3: MODBUS address

Word n° 4: *Reserved*

Words n° 5 & 6 & 7 & 8: Event date is Inverted IEC 870-5-4 CP56Time2a:

See format Page 8h

Word n° 9: Acknowledge
0=event non acknowledged
1= event acknowledged)

Code	Meaning of the event	Type	MODBUS address
00	No event	-	
01	Remote & front panel closing	F38	0400h (bit 15)
02	Remote & front panel tripping	F38	0400h (bit 7)
03	Delatch outputs	F38	0400h (bit 2)
04	Delatch LEDs	F38	0400h (bit 1)
05	Delatch outputs and LEDs	F38	0400h (bit 3)
06	Clear Fault Recorder	F38	0400h (bit 4)
07	Clear Event Recorder	F38	0400h (bit 5)
08	Setting change	F32↑↓	0009h
09	Reserved		
10	Reserved		
11	Protection disable startus	F12↑↓	0011h
12	I>	F37↑↓	0019h (bit 0)
13	I>>	F37↑↓	001Ah (bit 0)
14	IN>	F50 ↑↓	001Ch (bit 0)
15	IN>>	F50 ↑↓	001Dh (bit 0)
16	tI>	F37↑↓	0019h (bit 6)
17	tI>>	F37↑↓	001Ah (bit 6)
18	tIN>	F50 ↑↓	001Ch (bit 6
19	tN>>	F50 ↑↓	001Dh (bit 6)
20	tAUX1	F51 ↑↓	001Fh (bit 6)
21	52a	F37 ↑↓	0016h (bit 5)
22	52b	F37 ↑↓	0016h (bit 6)
23	52	F17 ↑↓	0016h (bit 7)
24	52 not defined	F17 ↑↓	0016h (bit 8)
25	CB not healthy	F17 ↑↓	0016h (bit 10)
26	Start CB Fail	F51 ↑↓	0021h (bit 0)

Code	Meaning of the event	Type	MODBUS address
27	Change of binary input state	F11 ↑↓	0010h
28	Change of output state	F24 ↑↓	0012h
29	I>>>	F37↑↓	001Bh (bit 0)
30	tI>>>	F37↑↓	001Bh (bit 6)
31	Iasym>	F50 ↑↓	001Eh (bit 0)
32	tIasym>	F50 ↑↓	001Eh (bit 6)
33	tAUX2	F51 ↑↓	0020 (bit 6)
34	CB Fail	F51 ↑↓	0021h (bit 6)
35	Setting Group 1 active	F32	0009h (bit 0)
36	Setting Group 2 active	F32	0009h (bit 1)
37	tI> Alarm	F37↑↓	0019h (bit 4)
38	tI>> Alarm	F37↑↓	001Ah (bit 4)
39	tI>>> Alarm	F37↑↓	001Bh (bit 4)
40	tIN> Alarm	F50 ↑↓	001Ch (bit 4)
41	tIN>> Alarm	F50 ↑↓	001Dh (bit 4)
42	tAUX1 Alarm	F51 ↑↓	001Fh (bit 4)
43	tAUX2 Alarm	F51 ↑↓	0020 (bit 4)
44	Iasym> Alarm	F50 ↑↓	001Eh (bit 4)
45	CB Fail Alarm	F51 ↑↓	0021h (bit 4)
46	Aux1	F51 ↑↓	001Fh (bit 0)
47	Aux2	F51 ↑↓	0020 (bit 0)
48	tAUX1 Trip	F29	014h (bit 12)
49	tAUX2 Trip	F29	014h (bit 13)

NOTE: The double arrow ↑↓ means the event is generated on event occurrence (↑) and on event disappearance (↓).

On event occurrence, the corresponding bit of the associated format is set to «1 ».

On event disappearance, the corresponding bit of the associated format is set to «0 ».

CT

2.4.12 Page 36h

Most older event data

Access in word reading (**function 03**)

Address	Contents
3600h	Most older event data

2.4.13 Page 37h: fault record value data

Access in word reading (**function 03**)

Address	Contents
3700h	Fault value record n°1
3701h	Fault value record n°2
3702h	Fault value record n°3
3703h	Fault value record n°4
3704h	Fault value record n°5

Word n° 1: Fault number

Words n° 2 & 3: Fault date (second) number of seconds since 01/01/94

Words n° 4 & 5: Fault date (millisecond)

Word n° 6: Fault date (season)
0= winter (not available in P115)
1= summer (not available in P115)
2= undefined (default value in P115)

Word n° 7: Active setting group during the fault (1 or 2)

Word n° 8: Fault origin
0= none
1= phase A
2= phase B
3= phase C
4= phases A-B
5= phases A-C
6= phases B-C
7= phases A-B-C
8= earth

Word n° 9: Fault recording starting origin

Fault nature code meaning

Code	Fault origin
00	Null event
01	Remote trip
02	Reserved
03	tI> trip
04	tI>> trip
05	tI>>> trip
06	tIN> trip
07	tIN>> trip
08	Reserved
09	Reserved
10	Reserved
11	t Aux 1 trip
12	t Aux 2 trip

Code	Fault origin
13	tIasym> trip
14	Reserved
15	Reserved
16	Reserved
17	Braker Failure trip
18	Reserved
19	Reserved
20	CBext trip

Word n° 10: Fault value current (nominal value)

Word n° 11: Phase A current value (nominal value)

Word n° 12: Phase B current value (nominal value)

Word n° 13: Phase C current value (nominal value)

Word n° 14: Earth current value (nominal value)

Word n° 15: Acknowledge of fault 0: fault non-acknowledged
1: fault acknowledged

2.4.13.1 Calculation formula for phase current values

Line phase current value (primary value) = phase sampled value (e.g. word 10, 11, 12 or 13) * {line primary CT ratio (address 0120h)/Line CT sec (address 0121h)} A/10.

2.4.13.2 Calculation formula for earth current values

The formula depends of nominal earth current:

0.01 to 2 Ien and 0.05-10Ien range
Line earth current value (primary value) = earth sampled value (e.g. word 10 or 14) * {line primary CT ratio (address 0122h)/Line CT sec (address 0123h)} A/1000.

0.2 to 40 Ien range
Line earth current value (primary value) = earth sampled value (e.g. word 10 or 14) * {line primary CT ratio (address 0122h)/Line CT sec (address 0123h)} A/10.

CT

2.4.14 Page 3Eh: most older Fault record value data

Access in word reading (**function 03**)

Address	Contents
3^{E}00h	Most older Fault record

2.4.15 Description of the mapping format, MiCOM P115 Dual-powered

CODE	DESCRIPTION
F1	Unsigned integer – numerical data: 1 – 65535
F10	Characters ASCII byte 1: ASCII character 32-127 byte 2: ASCII character 32-127
F11	Unsigned integer -Binary input status bit 0: binary input 1 bit 1: binary input 2 bit: 2-15 reserved
F12	Unsigned integer - Protection disable status bits: 0 to 4 reserved bit 5: I> disabled bit 6: I>> disabled bit 7: I>>> disabled bit 8: IN> disabled bit 9: IN>> disabled bit 10: Iasym> disabled bit 11: AUX1 disabled bit 12: AUX2 disabled bit 13: CB Fail disabled bit 14 to 15: reserved
F15	Two-digit decimal number - Firmware version 1st digit - major version 2nd digit - minor version 10: 1A 11: 1B 12: 1C 13: 1D etc
F16	Unsigned integer – Configuration 0: disabled 1: enable Trip 2: enable Alarm
F17	Unsigned integer - Hardware version : 00: 2BO, no RS485 : 01: 2BO; RS485 : 10: 4BO, no RS485 : 11: 4B0, RS485
F18	Unsigned integer – curves type 0: DTM 1: STI (IEC) 2: SI (IEC) 3: VI (IEC) 4: LTI (IEC) 5: STI (IEC) 6: RC Rectifier curve 7: RI curve 8: MI (ANSI) 9: VI (ANSI) 10: EI (ANSI) 11: STI (C02) 12: LTI (CO8)

CODE	DESCRIPTION
F19	Unsigned integer - Baud rate value 0: 4800 baud 1: 9600 baud 2: 19200 baud 3: 38400 baud 4: 57600 baud 5: 115200 baud
F20	Unsigned integer – Parity 0: NONE 1: EVEN 2: ODD
F22	Unsigned integer – Stop 0: 1 stop 1: 2 stop
F23	Unsigned integer 0: 1A 1: 5A
F24	Unsigned integer - Logical output status bit 0: logic output RL1 bit 1: logic output RL2 bit 2: logic output RL3 bit 3: logic output RL4 bit 4-15: reserved
F25	Unsigned integer - Logical LED status bit 0: Healthy bit 1: Trip bit 2: LED3 bit 3: LED4 bit 4: LED5 bit 5: LED6 bit 6: LED7 bit 7: LED8 bit 8-15: reserved
F26	Unsigned integer - Logical heathy status bit 0 to 3 reserved bit 4: Healthy bit10-15: reserved
F27	Unsigned Integer
F28	Unsigned integer - Protection start status bit 0: Any Start bit 1: starting in phase A bit 2: starting in phase B bit 3: starting in phase C bit 4: starting in N bit 5: I> bit 6: I>> bit 7: I>>> bit 8: IN> bit 9: IN>> bit 10: reserved bit 11: Iasym> bit 12: AUX1 bit 13: AUX2 bit 14: CB Fail bit 15: CB ext

CODE	DESCRIPTION
F29	Unsigned integer - Protection trip status bit 0: Any Trip bit 1: Trip in phase A bit 2: Trip in phase B bit 3: Trip in phase C bit 4: Trip in N bit 5: tI> bit 6: tI>> bit 7: tI>>> bit 8: tIN> bit 9: tIN>> bit 10: reserved bit 11: tIasym> bit 12: tAUX1 bit 13: tAUX2 bit 14: tCB Fail bit 15: CB ext
F30	Unsigned integer - CB status 0: 52A 1: 52B 2: 52 faulty 3: 52 not defined
F31	Unsigned integer - E/Gnd CT Sec 0: Ien=1A, 0.01-2Ien; 1: Ien=1A, 0.05-10Ien; 2: In=1A, 0.2-40In 3: 5A, 0.01-2In 4: In=5A, 0.05-10In 5: In=6A, 0.2-40In
F32	Unsigned integer -Setting group 0: Setting group 0 1: Setting group 1
F33	Unsigned integer –Output Configuration bit 0: RL1 bit 1: RL2 bit 2: RL3 (refer to hardware ver.) bit 3: RL4 (refer to hardware ver.) bit 4: Flag indicator bit 5-15: reserved
F35	Unsigned integer -Input configuration bit 0: Input L1 bit 1: Input L2 bit 2-15: reserved
F36	Unsigned integer -Output configuration bit 0: RL1 bit 1: RL2 bit 2: RL3 (refer to hardware ver.) bit 3: RL4 (refer to hardware ver.) bit 4-15: reserved
F37	Unsigned integer: Phase Threshold Information Status bit 0: information thresold exceeded (I>, I>>, I>>>) bit 1: Instantaneous IA bit 2: Instantaneous IB bit 3: Instantaneous IC bit 4: reserved bit 5: Instantaneous i I> or I>> or I>>> (after blocking) bit 6: Tripping information tI> or tI>> or tI>>> bit 7 to 15: reserved

CODE	DESCRIPTION
F38	Unsigned integer - Remote Control Word bit 0: Warm restart bit 1: Reset LEDs bit 3: Reset LEDs and Outputs bit 4: Clear fault recorder bit 5: Clear event recorder bit 7: CB open bit 8-11: Reserved bit 12: Local maintenace acknowledge bit 13: Oldest event acknowledge bit 14: Oldest fault acknowledge bit 15: CB close
F39	Unsigned integer - LED Function bit 0: LED3 bit 1: LED4 bit 2: LED5 bit 3: LED6 bit 4: LED7 bit 5: LED8 bit 6-15: reserved
F40	Unsigned integer -Output Configuration (bit fields) bit 0: RL1 bit 1: RL2 bit 2: RL3 (refer to hardware ver.) bit 3: RL4 (refer to hardware ver.) bit 4: Trip Output bit 5: Flag indicator bit 6-15: reserved
F41	Unsigned integer - Curve Type 0: DT 1: IDMT
F49	Unsigned integer - Relay Status bit 0: Relay status (major alarms) bit 1: Minor hardware alarm bit 2: Presence of non-acknowledged event bit 3: Synchronisation state bit 4: reserved bit 5: Presence of non-acknowledged fault record bit 6-15: reserved
F50	Unsigned integer: Earth Threshold Information Status bit 0: information threshold exceeded (IN> or IN>> or Iasym>) bit 1-4: reserved bit 5: Instantaneous IN> or IN>> or Iasym> (after blocking) bit 6: Tripping information tIN> or tIN>> or tIasym> bit 7 to 15: reserved
F51	Unsigned integer: Information Status about Additional Protection bit 0: start AUX1 or AUX2 or CB Fail or CBF ext. bit 1-4: reserved bit 5: start (after blocking) AUX1 or AUX2 or CB Fail or CBF ext. bit 6: tripping information tAUX1 or tAUX2 or tCB Fail or CBF ext bit 7 to 15: reserved

CODE	DESCRIPTION
F52	Unsigned integer: Menu Language Information 0: English 1: German 2: Polish 3: French 4: Spanish 5: Regional
F53	Unsigned integer: Measurements Display in the menu 0: Measurements refered to In or Ien 1: Measurements refered to A 2: Control window
F54	Unsigned integer: LEDs Reset by Protection Start 0: No 1: Yes
F55	Unsigned integer: Alarm Display Reset 0: Self-Reset 1: Manual Reset
F56	Unsigned integer: Protocol 0: Modbus 1: IEC103
F60	Inverted CP56Time2a Format
F80	Unsigned integer - Event code / value byte 0: event code (see: Events Mapping) byte 1: associated value

2.4.16 Request to retrieve the oldest non-acknowledge event

Slave number	Function code	Word address	Word number	CRC
xx	03h	36h 00	00 09h	xx xx

This event request may be answered an error message with the error code:
EVT_EN_COURS_ECRIT (5): An event is being written into the saved FRAM.

Note: On event retrieval, two possibilities exist regarding the event record acknowledgement:
a) Automatic event record acknowledgement on event retrieval.
b) Non automatic event record acknowledgement on event retrieval.

a) Automatic event record acknowledgement on event retrieval:

The bit12 of the remote order frame (format F38 – mapping address 0400h) shall be set to 0. On event retrieval, this event record is acknowledged.

b) Non automatic event record acknowledgement on event retrieval:

The bit12 of the remote order frame (format F38 – mapping address 0400h) shall be set to 1. On event retrieval, this event record is not acknowledged.
To acknowledge this event, an other remote order shall be sent to the relay. The bit 13 of this frame (format F38 – mapping address 0400h) shall be set to 1.

2.4.17 Request to retrieve a dedicated event

Slave number	Function code	Word address	Word number	CRC
xx	03h	Refer to mapping	00 09h	xx xx

This event request may be answered an error message with the error code:
EVT_EN_COURS_ECRIT (5): An event is being written into the saved FRAM.

Note: This event retrieval does not acknowledge this event.

2.4.18 Modbus request definition used to retrieve the fault records

Two ways can be followed to retrieve a fault record:

- Send a request to retrieve the oldest non-acknowledge fault record.
- Send a request to retrieve a dedicated fault record.

2.4.18.1 Request to retrieve the oldest non-acknowledge fault record

Slave number	Function code	Word address	Word number	CRC
xx	03h	3Eh 00	00 0Fh	xx xx

Note: On fault retrieval, two possibilities exist regarding the fault record acknowledgement:
a) Automatic fault record acknowledgement on event retrieval.
b) Non automatic fault record acknowledgement on event retrieval.

a) Automatic fault record acknowledgement on fault retrieval:

The bit12 of the remote order frame (format F38 – mapping address 0400h) shall be set to 0. On fault retrieval, this fault record is acknowledged.

b) Non automatic fault record acknowledgement on fault retrieval:

The bit12 of the remote order frame (format F38 – mapping address 0400h) shall be set to 1. On fault retrieval, this fault record is not acknowledged.
To acknowledge this fault, an other remote order shall be sent to the relay. The bit 14 of this frame (format F38 – mapping address 0400h) shall be set to 1.

2.4.18.2 Request to retrieve a dedicated fault record

Slave number	Function code	Word address	Word number	CRC
xx	03h	Refer to mapping	00 0Fh	xx xx

Note: This fault value retrieval does not acknowledge this fault record.

3. IEC60870-5-103 INTERFACE

The IEC60870-5-103 interface is a master/slave interface with the relay as the slave device. This protocol is based on the VDEW communication protocol. The relay conforms to compatibility level 2, compatibility level 3 is not supported.

The following IEC60870-5-103 facilities are supported by this interface:

- Initialisation (Reset)
- Time Synchronisation
- Event Record Extraction
- General Interrogation
- Cyclic Measurements
- General Commands

3.1 Physical connection and link layer

Connection is available for IEC60870-5-103 through the rear RS485 port. It is possible to select both the relay address and baud rate using the front panel interface. Following a change, a reset command is required to re-establish communications.

The parameters of the communication are the following:

- Even Parity
- 8 Data bits
- 1 stop bit
- Data rate 9600 or 19200 bauds

3.2 Initialisation

Whenever the relay has been powered up, or if the communication parameters have been changed a reset command is required to initialise the communications. The relay will respond to either of the two reset commands (Reset CU or Reset FCB), the difference being that the Reset CU will clear any unsent messages in the relay's transmit buffer.

The relay will respond to the reset command with an identification message ASDU 5, the Cause Of Transmission COT of this response will be either Reset CU or Reset FCB depending on the nature of the reset command. The following information will be contained in the data section of this ASDU:

Manufacturer Name: Schneider Electric

The Software Identification Section will contain the first four characters of the relay model number to identify the type of relay, eg P115.

In addition to the above identification message, if the relay has been powered up it will also produce a power up event.

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3.3 Time synchronisation

The relay time and date can be set using the time synchronisation feature of the IEC60870-5-103 protocol. The relay will correct for the transmission delay as specified in IEC60870-5-103. If the time synchronisation message is sent as a send/confirm message then the relay will respond with a confirm. Whether the time synchronisation message is sent as a send confirm or a broadcast (send/no reply) message, a time synchronisation message will be returned as Class 1 data.

3.4 Spontaneous events

The events created by the relay will be passed using the standard function type/information numbers to the IEC60870-5-103 master station. Private codes are not used, thus any events that cannot be passed using the standardised messages will not be sent.

Events are categorised using the following information:

- Common Address
- Function Type
- Information number

3.10-3.14 contains a complete listing of all events produced by the relay. The common address is used to differentiate in circumstances where the relay produces more events of a certain type than can be passed using the standardised messages. For example if the relay produces starts and trips for three stages of overcurrent only two stages can be passed using the standardised messages.

Using the different common address for two of the overcurrent stages allows each stage to be indicated. 3.10-3.14 shows the common address as an offset value. The common address offset will be added to the station address in order to pass these events.

3.5 General interrogation

The GI request can be used to read the status of the relay, the function numbers, information numbers and common address offsets that will be returned during the GI cycle are indicated in 3.10-3.14.

3.6 Cyclic measurements

The relay will produce measured values using ASDU 9 on a cyclical basis, this can be read from the relay using a Class 2 poll (note ADSU 3 is not used).

It should be noted that the measurands transmitted by the relay are sent as a proportion of 2.4 times the rated value of the analogue value. The selection of 2.4 for a particular value is indicated in 3.10-3.14.

3.7 Commands

A list of the supported commands is contained in 3.10-3.14. The relay will respond to other commands with an ASDU 1, with a cause of transmission (COT) of negative acknowledgement of a command.

3.8 Disturbance records

The relay does not support a facility for disturbance records in the Monitor direction.IEC 60870-5-103 DATABASES.

3.9 Blocking of monitor direction

The relay does not support a facility to block messages in the Monitor direction.IEC 60870-5-103 DATABASES.

3.10 Spontaneous messages managed by MiCOM P115

These messages includes a sub-assembly of events which are generated on the relay, because some generated events are not registered in VDEW. They are the most priority messages.

An event is always generated on the rising edge of the information.

Some events can be generated on the rising or lowering edge.

In the list below, events only generated on rising edge will be tagged with a '*'.

ASDU 1 (time-tagged message) is generated for events.

The following list of processed events is the list **with the private messages option active**, for all Overcurrent protection functions, with the associated FUNCTION Type, INFORMATION NUMBER, ASDU TYPE, CAUSE OF TRANSMISSION and COMMON ADDRESS OF ASDU (The corresponding numbers with **private messages option inactive** are given just below).

FUN <160>: Function type in Public range for Overcurrent Protections (compatible).

FUN <168>: Function type in Private range (Reserved for Overcurrent Protections).

Status indications in monitor direction: Availability

- LEDs reset: FUN<160>;INF <19>; TYP <1>; COT^{LED}; <ADDR>,↑↓
- Setting Group number 1 active: FUN<160>;INF <23>; TYP <1>; COT<1>,<ADDR>
- Setting Group number 2 active: FUN<160>;INF <24>; TYP <1>; COT<1>,<ADDR>
- Auxiliary input 1: FUN<160>;INF <27>; TYP <1>; COT<1>,<ADDR>
- Auxiliary input 2: FUN<160>;INF <28>; TYP <1>; COT<1>,<ADDR>
- Logical input 1: FUN<168>;INF <160>; TYP <1>; COT<1>,<ADDR
- Logical input 2: FUN<168>;INF <161>; TYP <1>; COT<1>,<ADDR>
- Logical output 1: FUN<168>;INF <176>; TYP <1>; COT<1>,<ADDR>
- Logical output 2: FUN<168>;INF <177>; TYP <1>; COT<1>,<ADDR>
- Logical output 3: FUN<168>;INF <178>; TYP <1>; COT<1>,<ADDR>
- Logical output 4: FUN<168>;INF <179>; TYP <1>; COT<1>,<ADDR>
- Supervision Indications in monitor direction: Availability
- Start / pick-up I>: FUN<168>;INF <9>; TYP <2>; COT<1>,<ADDR>
- Start / pick-up I>>: FUN<168>;INF <10>; TYP <2>; COT<1>,<ADDR>
- Start / pick-up I>>>: FUN<168>;INF <11>; TYP <2>; COT<1>,<ADDR>
- Start / pick-up IN>: FUN<168>;INF <12>; TYP <2>; COT<1>,<ADDR>
- Start / pick-up IN>>: FUN<168>;INF <13>; TYP <2>; COT<1>,<ADDR>
- Trip I>: FUN<160>;INF <90>; TYP <2>; COT<1>,<ADDR>,↑↓
- Trip I>>: FUN<160>;INF <91>; TYP <2>; COT<1>,<ADDR>,↑↓
- Trip I>>>: FUN<168>;INF <19>; TYP <2>; COT<1>,<ADDR>,↑↓
- Trip IN>: FUN<160>;INF <92>; TYP <2>; COT<1>,<ADDR>,↑↓
- Trip IN>>: FUN<160>;INF <93>; TYP <2>; COT<1>,<ADDR>,↑↓
- CB in O/O («closed ») position: FUN<168>;INF <33>; TYP <1>;COT<1>,<ADDR
- CB in F/O («open ») position: FUN<168>;INF <34>; TYP <1>;COT<1>,<ADDR>

Notes:
1. The double arrow ↑↓ means that the event generated on event occurrence and another event is generated on event disappearing.
2. COT^{LED} can be LOCAL (COT<11>) or REMOTE (COT<12>)

3.11 List of data contained in General Interrogation

It is given in the answer to the General Interrogation (GI).

Relay state information are Class 1 data, they are systematically sent to the master station, during a General Interrogation.

The list of processed data, following a General Interrogation, is given below: it is a sub-assembly of the spontaneous message list, so like spontaneous messages, these data are generated on rising and lowering edge.

Status indications (monitor direction): Availability

- Leds reset: FUN<160>;INF <19>; TYP <1>; COT<9>,<ADDR>,↑↓
- Setting Group number 1 active: FUN<160>;INF <23>; TYP <1>; COT<9>,<ADDR>
- Setting Group number 2 active: FUN<160>;INF <24>; TYP <1>; COT<9>,<ADDR>
- Auxiliary input 1: FUN<160>;INF <27>; TYP <1>; COT<9>,<ADDR>
- Auxiliary input 2: FUN<160>;INF <28>; TYP <1>; COT<9>,<ADDR>
- Logical input 1: FUN<168>;INF <160>; TYP <1>; COT<9>,<ADDR>
- Logical input 2: FUN<168>;INF <161>; TYP <1>; COT<9>,<ADDR>
- Logical output 1: FUN<168>;INF <176>; TYP <1>; COT<9>,<ADDR>
- Logical output 2: FUN<168>;INF <177>; TYP <1>; COT<9>,<ADDR>
- Logical output 3: FUN<168>;INF <178>; TYP <1>; COT<9>,<ADDR>
- Logical output 4: FUN<168>;INF <179>; TYP <1>; COT<9>,<ADDR>
- CB in O/O (“closed”) position: FUN<168>;INF <33>; TYP <1>; COT<9>,<ADDR>
- CB in F/O (“open”) position: FUN<168>;INF <34>; TYP <1>; COT<9>,<ADDR>

3.12 Processed Commands

System Commands: Availability

Synchronization Command (ASDU 6): FUN<255>,INF <0>; TYP <6>;COT<8>

This command can be sent to a specific relay, or global. The time sent by master is the time of the first bit of the frame. The relay synchronizes with this time, corrected by the frame transmission delay. After updating its time, the relay send back an acknowledge to the master, by giving its new current time.

This acknowledge message will be an event of ASDU 6 type.

General Interrogation Initialization command (ASDU 7):

FUN<255>;INF <0>;TYP <7>; COT<9>

This command starts the relay interrogation:

The relay then sends a list of data containing the relay state (see list described above).

The GI command contains a scan number which will be included in the answers of the GI cycle generated by the GI command.

If a data has just changed before extracted by the GI, the new state is sent to the master station.

When an event is generated during the GI cycle, the event is sent in priority, and the GI cycle is temporarily interrupted. The end of the GI consists in sending an ASDU 8 to the master station.

If, during a General Interrogation cycle, another GI Initialization command is received, the precedent answer is stopped, and the new GI cycle started.

General Commands (ASDU 20) (Control direction): Availability

- LEDs Reset: This command acknowledge all alarms on Front Panel on MiCOM P115 products:

  FUN<160>;INF<19>, TYP<20>, COT <20>,<ADDR>

- Setting group number 1: FUN<160>;INF<23>, TYP<20>, COT <20>,<ADDR>
- Setting group number 2: FUN<160>;INF<24>, TYP<20>, COT <20>,<ADDR>
- Trip TC: FUN<168>;INF <1>; TYP <20>; COT<20>,<ADDR>
- Close TC: FUN<168>;INF <2>; TYP <20>; COT<20>,<ADDR>

After executing one of these commands, the relay sends an acknowledge message, which contains the result of command execution.

If a state change is the consequence of the command, it must be sent in a ASDU 1 with COT 12 (remote operation).

If the relay receive another command message from the master station before sending the acknowledge message, it will be discarded.

Commands which are not processed by the relay are rejected with a negative acknowledge message.

3.13 Relay re initialization

In case of relay re initialization, the relay send to the master station: Availability

A message indicating relay start/restart (FUN<160>;INF <5>; TYP <5> COT <5>) or a message indicating Reset CU (FUN<160>;INF <5>; TYP <3> COT <4>) or a message indicating Reset FCB (FUN<160>;INF <5>; TYP <2> COT <3>).

Each identification message of the relay (ASDU 5) contains the manufacturer name in 8 ASCII characters et 4 free characters containing: «P115 ».

3.14 Cyclic Messages (ASDU9)

Only measurands can be stored in these messages.

The measurands values are stored in lower levels of communication, before polling by master station.

Several of the fields in the ASDU 9 (FUN<160>,INF <148>) and ASDU 3 (FUN<160>,INF<147>) are unused in the P115 relay. Only Ia, Ib, Ic values are stored (with a rate such as: 2,4 * nominal value = 4096).

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FIRMWARE AND SERVICE MANUAL VERSION HISTORY

Date:	**20th February 2009**
Hardware Suffix:	**A**
Software Version:	**1D**
Connection Diagrams:	**10P11504**

VH

Relay type: P115 …						
Software Version		**Hardware Suffix**	**Original Date of Issue**	**Description of Changes**	**S1 Compatibility**	**Technical Documentation**
Major	Minor					
1	A	A	November 2007	✓ Original Issue	V2.12	P115/EN M/A31
1	B	A	April 2008	✓ Added: Protection start in LEDs' configuration ✓ Added: German language	V2.12	P115/EN M/A21
1	C	A	September 2008	✓ Added: IEC103 protocol ✓ Added: French language ✓ Added: Spanish Language	V2.12	P115/EN M/A31

Relay type: P115 …						
Software Version		**Hardware Suffix**	**Original Date of Issue**	**Description of Changes**	**S1 Compatibility**	**Technical Documentation**
Major	Minor					
1	D	A	February 2009	✓ Added: Polish language ✓ Added: Regional language ✓ Added: Switchable Modbus/IEC protocol ✓ Added: Output tests (*COMMISSIONING/ Test Pattern* and *COMMISSIONING/ Test outputs cells)* ✓ Added: self-reset of latched LEDs by starting of protection (*GLOBAL SETTINGS/ LOC/LEDs Reset by Start*) ✓ Added: latching of Alarm indication in *ALARM* column (*GLOBAL SETTINGS/ LOC/Alarm Display)*. ✓ Added: remaining latched Alarms cells (*ALARM STATUS/ Alarm Reset*) ✓ Modified a start of switching on the LCD display logic. Added a setting pertaining to the IN connection *(GLOBAL SETTINGS/ CIRCUIT BREAKER/ IN connection)* ✓ Added: Flag indicator and Tripping Coil option are configurable for functions chosen in Outputs configuration ✓ Added: new functions: Start Phase A, Start Phase B, Start Phase C, Start Earth In outputs and LEDs configuration columns		P115/EN M/A41

Setting File Software Version	Relay Software Version																										
	1A	1B	1C	1D																							
1A	✓	✓	✓																								
1B	✓	✓	✓																								
1C	✓	✓	✓																								
1D	✓	✓	✓	✓																							

VH

Customer Care Centre

http://www.schneider-electric.com/CCC

Schneider Electric

35 rue Joseph Monier
92506 Rueil-Malmaison
FRANCE

Phone: +33 (0) 1 41 29 70 00
Fax: +33 (0) 1 41 29 71 00

www.schneider-electric.com

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